COMPARATIVE ANALYTICAL STUDY OUTCOME OF MULTIDIRECTIONAL LOCKED NAILING AND PLATING FOR DISTAL TIBIAL FRCTURES

Dissertation submitted for

M.S DEGREE EXAMINATION

BRANCH II-ORTHOPAEDIC SURGERY

INSTITUTE OF ORTHOPAEDICS AND TRAUMATOLOGY

MADRAS MEDICAL COLLEGE AND RAJIV GANDHI GOVERNMENT GENERAL HOSPITAL CHENNAI-600003

THE TAMILNADU DR.M.G.R MEDICAL UNIVERSITY, CHENNAI-600032

MARCH-2015

CERTIFICATE

This is to certify that this dissertation in "**COMPARATIVE ANALYTICAL STUDY OUTCOME OF MULTIDIRECTIONAL LOCKED NAILING AND PLATING FOR DISTAL TIBIAL FRACTURES**" is a bonafide work done by Dr.A.ANAND KUMAR under my guidance during the period 2012–2015. This has been submitted in partial fulfilment of the award of M.S. Degree in Orthopedic Surgery (Branch–II) by The TamilnaduDr.M.G.R. Medical University, Chennai.

Prof.A.PANDIASELVAN
Professor,
Institute of Orthopaedics and Traumatology,
Madras Medical College,
Rajiv Gandhi Govt. General Hospital, Chennai-600 003.

Prof R.ARUNMOZHIMARAN VIJAYABABU
Director,
Institute of Orthopaedics and Traumatology
Madras Medical College
Rajiv Gandhi Govt. General Hospital, Chennai-600 003.

,

Dr. R.VIMALA, M.D.,
Dean,
Madras Medical College,
Rajiv Gandhi Govt. General Hospital,
Chennai – 600003.

CERTIFICATE

This is to certify that this dissertation in"**COMPARATIVE ANALYTICAL STUDY OUTCOME OF MULTIDIRECTIONAL LOCKED NAILING AND PLATING FOR DISTAL TIBIAL FRACTURES**" is a bonafide work done by Dr.A.ANAND KUMAR under my guidance during the period 2012–2015. This has been submitted in partial fulfilment of the award of M.S. Degree in Orthopedic Surgery (Branch–II) by The TamilnaduDr.M.G.R. Medical University, Chennai

Prof R.ARUNMOZHIMARAN VIJAYABABU,
M.S.Ortho.,D.Ortho.,
Director & Professor,
Institute Of Orthopaedics & Truamatology
Madras Medical College
Rajiv Gandhi Govt Gen. Hospital,
Chennai-600003.

DECLARATION

I, Dr.A.ANAND KUMAR, solemnly declare that the dissertation titled "**COMPARATIVE ANALYTICAL STUDY OUTCOME OF MULTIDIRECTIONAL LOCKED NAILING AND PLATING FOR DISTAL TIBIAL FRACTURES**" done by me at the Rajiv Gandhi Government General Hospital, Chennai-3, during 2013-2015 under the guidance of my unit chief Prof.A.PANDIA SELVAN, M.S(Ortho), D.Ortho., The dissertation is submitted in partial fulfilment of requirement for the award of M.S. Degree (Branch –II) in Orthopaedic Surgery to The Tamil Nadu Dr.M.G.R.Medical University.

Place:

Date: **Dr.A.ANAND KUMAR**

ACKNOWLEDGEMENT

I am grateful to Prof. **Dr.R.VIMALA**, Dean, Madras Medical College,Chennai for providing me an opportunity to conduct this study study and utilize the clinical materials of this hospital.

I would like to express my gratitude and reverence to **Prof.R.ARUNMOZHIMARAN VIJAYABABU M.S.Ortho.,D.Ortho.,** the Director and the Head of the Department, Institute of Orthopaedics and Traumatology , Madras Medical College and Rajiv Gandhi Govt GenaralHospital, Chennai -03 whose guidance and help has elevated me to this level, to conduct this study successfully. I sincerely thank his expert guidance and constant encouragement to conduct this study.

I would like to express my sincere thanks and gratitude to our beloved chief **Prof.A.PANDIA SELVAN M.S.Ortho.,D.Ortho.**, Madras Medical College and Rajiv Gandhi Govt GenaralHospital, Chennai -03, whose guidance and help has elevated me to this level, to conduct this study successfully.I sincerely thank his expert guidance and constant encouragement to conduct this study.

My sincere thanks and gratitude to **Prof N. Deen Mohd.Ismail. M.S.Ortho., D.Ortho.,** Professor, Institute of Orthopaedics and Traumatology, for his constant advice and guidance provided throughout this study.

My sincere thanks and gratitude to **Prof. V. SINGARAVADIVELU M.S.Ortho., D.Ortho.,** Professor, Institute of Orthopaedics and Traumatology, for his constant advice and guidance provided throughout this study.

My sincere thanks and gratitude to **Prof.SUDHEER M.S.Ortho., D.Ortho.,** Professor, Institute of Orthopaedics and Traumatology, for his valuable advice and guidance.

My sincere thanks and gratitude to **Prof. NALLI R. UVARAJ M.S.Ortho., D.Ortho.,** for his constant advice and guidance provided throughout this study.

I am very much grateful to **Prof.KARUNAKARAN M.S.Ortho.,** for his unrestricted help and advice throughout the study period.

My sincere thanks and gratitude to **Dr.P.KINGSLYM.S.Ortho.,D.Ortho.,**who has been my guide in every aspect of this study. He has taken pains to offer valuable suggestions for this study.

I also thank

Dr. Prabhakar ,

Dr. Nalli.R.Gopinath

Dr. Senthil sailesh

Dr.Kannan

Dr. Hemanth kumar

Dr. Muthu kumar

Dr.Sameer

Dr.Kaliraj

Dr.Palanzhi

Dr.Sarath babu

Dr.Saravanan

Dr.Suresh anand

Dr.Raj Ganesh

Dr.Muthalagan

All my Assistant Professors for their valuable advice and guidance.

I wish to express my thanks to anesthesiologists, postgraduate colleagues, staff members, and theatre staff for the help they have rendered.

I thank all my patients who gave full cooperation for this study without whom this study would not be possible.

Not but not the least, I offer my sincere prayers to God Almighty.

Dr. A.ANAND KUMAR

COMPARATIVE ANALYTICAL STUDY OUTCOME OF MULTIDIRECTIONAL LOCKED NAILING AND PLATING FOR DISTAL TIBIAL FRACTURES

ABSTRACT

INTRODUCTION: Distal tibial fractures are very commonly encountered by orthopaedic surgeons. Our aim is to study and compare clinical and radiological outcome in extra articular fractures of distal tibia treated by multidirectional interlocking intramedullary nails and anterolateral locking compressio plates with reference to rate of healing, functional outcome and complications.

MATERIAL AND METHODS: In this study 24 patients with distal tibia extrarticular fractures, AO type 43 A1,43A 2,43A3 were randomly selected and 12 of them were operated with multidirectional interlocking nailing and remaining 12 with anterolateral locking compression plate. The patients were regularly followed up for a period of one year and were evaluated clinically and radiologically with respect to tenderness at fracture site, abnormal mobility, infection, pain on movement of knee, ankle joints and anteroposterior and lateral radiographs of the leg for union of the fracture.

RESULTS: In multidirectional Interlocking intramedullary group average time for union was 4.5months compared to 6.4 months in plating group which was significant (p value <0.00). Also the average time required for partial and full weight bearing in the nailing group was 4.2 weeks and 9.6 weeks respectively which was significantly less (p value <0.00) as compared to 7.12 weeks and 13.42 weeks in the plating group. Lesser complications in terms of

implant irritation, ankle stiffness and infection (superficial and deep) were seen in interlocking group as compared to plating group.

CONCLUSION: We concluded that due to early weight bearing, early union of the fracture and decreased implant related problems and closed intramedullary interlocking nailing is preferable in treatment of distal tibia fractures. We recommend fibular fixation whenever intramedullary nailing or locking plate fixation is used in distal tibiofibular fractures.

KEYWORDS: Distal Tibia Fractures, Fibular Fixation, Locking Plate, Interlocking Nailing.

CONTENTS

S.NO	TITLE	PAGE NO
1.	INTRODUCTION	1
2.	AIM AND OBJECTIVE	7
3.	REVIEW OF LITERATURE	8
4.	ANATOMY	20
5.	MATERIALS AND METHODS	36
6.	SURGICAL MANAGAMENT	42
7.	CASE ILLUSTRATIONS	54
8.	COMPLICATONS	68
9.	RESULTS AND OBSERVATIONS	73
10.	DISCUSSION	95
11.	CONCLUSION	103
12.	BIBLIOGRAPHY	
13.	PROFORMA	
14.	ANNEXURE	
	a) Patient Consent Form b) Tamil Consent Form c) Plagiarism d) Ethical Committee Apporoval	
15.	MASTER CHART	

INTRODUCTION

Distal tibial fractures represent less than 7%[1,2] of all tibial fractures. Of all lower extremity fractures less than 10%[3,4] belongs to distal tibial fractures.It is more common in males in the age group[5] of 30-50 yrs .The spectrum of injuries vary from low energy to high energy injuries.

The low energy distal tibial fractures are mainly seen in older age group ,usually due to rotational forces[6].The spiral fracture with or without intra articular extension is commonly encountered in these mechanism of injuries. In high energy distal tibial fractures younger age groups are involved due to road traffic accident and fall from height[7]. Axial loading, compression and torsional forces[8,9,10] are involved in the mechanism of injury.

The distal tibial fractures are mainly due to road traffic accident , fall from height and twisting of ankle.Fractures around the ankle joint are difficult to manage because of precarious vasculature in nature. In addition the the tibia is subcutaneously in plane which adds further difficulty in the fracture management.

Internal fixation devices such as locking compression plates , intramedullary nails are used for the fracture fixation of distal tibia.It is critical to understand the fracture pattern occurring in the distal tibia and the form of fixation available.

85 % distal tibial fractures was associated with the fibula fractures.The fixation of fibula is a debate according to many literature[7]. In case of rigid fixation like multidirectional interlocking nailing the fibular fracture need not be fixed,but for better reduction the fibula fracture may be fixed.

The comorbid conditions like diabetes mellitus, peripheral vascular diseases, smoking and alcoholism complicates this delicate situation[7].

In 1980, Ruedi et al made a gold standard decision to fix all distal tibial fractures by means of internal fixation by plate osteosynthesis.High complications like wound dehiscence,sepsis, chronic osteomyelities associated with open reduction and internal fixation with plating were noted in high energy fracture pattern

About 40 to 50% complication rate was attributed in internal fixation device and extensive surgical procedure due to soft tissue injury.

In 1990, the ankle spanning external fixation become popular to maintain the articular surface of tibia with minimal internal fixation.To maintain the length and axial alignment the fibular fractures were fixed with plate osteosynthesis.Monolateral external fixator was replaced by hybrid external fixators due to the advantage of the early weight bearing and stability.Management of open distal tibial fractures with external fixators as a definitive procedure has its own complication like ankle stiffness, pin tract infection,secondary loss of reduction and stability.

With the better understanding the management of soft tissue injury and the poor outcome results in the external fixation technique,makes to reconsidered that, after the soft tissue recovery open reduction and internal fixation can be done.

Non surgical management[11,12,13] have a limited role in medically unfit patient.For those patient the treatment modalities are traction or plaster of paris but the complication rate is higher like shortening ,malunion,secondary osteoarthritis of the ankle and

limited range of movements.In addition to the long bed ridden patient are more prone for pneumonia,deep vein thrombosis and pressure sores are encountered.

Tscherne classification of soft tissue injury was accepted by the AO group to grade and evaluate each component the skin ,neurovascular tissue and the musculotendinous structure gaveway for reconsideration of open reduction and internal fixation of distal tibial fractures.

For distal tibial fractures various modalities of internal fixation have been described.They are anterior plating using t-plates, AO medial plating using medial buttress plate, cloverleaf plate and dynamic compression plates.Each plate osteosynthesis has their own advantages and their complications.One of the major disadvantage of AO medial buttress plating is the wound dehiscence over the sub cutaneous border, lead on to flap cover by the plastic team and this procedure limits the lateral surgical approach for the fixation of the fibular fracture .

The locking compression plates with the anatomical contoured version is now available for better reduction of the distal tibia fracture .Use of low profile medial locking compression

plate still address the problem of wound dehiscence and deep infection with low complication rate than the standard AO plating.

In the Minimally Invasive Percutaneous Plate Osteosynthesis technique (MIPPO),the surgeons address minimal soft tissue injury in the management of distal tibial fractures.The union rate ranges from 80 to 100% in the MIPPO technique.in MIPPO procedure the surgical trauma to the soft tissue is minimised and it provides the biological environment for fractrure healing.The complication like hard ware failure , non union, angular deformity, malreduction has been reported

Anterolateral approach[14] described in the past was not popularized in the late century,anteroplating on the lateral surface of the tibia becoming popular for the fixation of distal tibial fractures and improved soft tissue coverage and low rate of wound.

Hey-Groves used solid metal rods for femur fractures and achieved healing at appropriate time, preservation of soft tissues, and periosteum as well as abolition of prolonged plaster cast immobilization.

Rush brothers presented their technique with multiple flexible intramedullary pins in 1927.

The most important contributions to intramedullary fixation, however, came from Gerhard Küntscher (1900-1972) who performed a number of animal experiments and explained not only the nailing technique but also the implant shape and design. He suggested a tight fit between nail and bone to achieve a higher stability . To extend the area of contact within the medullary cavity, he started to ream the canal in order to insert thicker, longer, and slotted cloverleaf nails.

In 1950,Herzog et al introduced the tibia nail with a proximal bend and lateral slots at the distal end to accept antirotational wires.

Klemm and Schnellmann in Germany and Kempf et al. in France further developed the idea and were precursors to today's interlocking nails.

In 1958 the AO/ASIF(Association for the study of internal fixation) formulated the four basic principles which have become the guidelines for the internal fixation.In general ,in particular to the intramedullary nailing they show anatomic reduction,stable fixation,preservation of blood supply and early mobilisation

AIMS AND OBJECTIVES

The aim of our study is to compare the functional outcome of the distal tibial fractures treated by multidirectional locked nailing and plating in the Institute of Orthopaedics and Traumatology, Madras Medical College ,Rajiv Gandhi Government General Hospital during the period of august 2013 to September 2014.

The primary objectives of the study is to analyze the outcome in terms of fracture union by means of clinical and radiological features.

The secondary objectives of the study is to analyze the outcome after surgical procedures.

REVIEW OF LITERATURE

In 1911,French radiologist Destot, first described that weight bearing distal tibial fractures are known as pilon fractures.

In the French language the term Pilon refers to the pestle, a club shaped tool used for grinding or masting substances in a mortar.

Etienne descot et al coined the term pilon to describe the fractures occurring within 5cm of the ankle joint

In 1956 Bonin et al, later described similar fracture pattern as a plafond fractures.

In 1968 Ruedi et al,for all plafond fractures performed open reduction and internal fixation[15,16] and demonstrated satisfactory results with few complications.

Heim et al, Ovadia the et al and Beals by their retrospective study supported the Ruedi et al study later.

Wyrsch et al noted that in Ruedi et al study low energy spiral fractures pattern was mostly included.

Kellam and Waddei et al based on the mechanism of injury in tibial pilon fractures divided into two types as rotationl or axial loading or both.

Pugh et al,Angen et al and their colleagues[17] al described the mal union, lower clincal scores and slower return to function as the complication of external fixation when they compared with their own open reduction and internal fixation group.

In 1996 Schatzker and Tile noted the distinction developed between the soft tissue that is adequate for immediate fixation and the soft tissue that is not suitable for surgery due to swelling. In the later group the skin and soft tissue are allowed a delay of 7 to 10 days prior to surgery to return to a reasonable state.

Mast et al recommended a temporary treatment if the definitive procedure cannot be performed within 8 to 12 hours. He recommended that for shortening due to fracture, calcaneal pin traction was applied to restore the length and for the length maintained stable injuries, casting can be applied temporarily before definitive procedure.

In 1999 Patterson et al ,Sirkin et al and their colleagues described the staged management of tibial plafond injuries. They

concluded that high rate of wound complication and sepsis in the immediate open reduction in the swollen and compromised soft tissue envelope.

In 2004 Helfet dl et al following better understanding of osseous fractures anatomy, developed low profile minimally invasive percutaneous plate osteosynthesis for distal tibial fractures

In Gorczya et al analyzed matched pairs of cadaveric tibia(with osteotomies at 4 cm and 5cm above the tibio talar joint) stated that comparable stiffness in compression and torsion is better in four centimetre distal tibial fragment stabilized with shortened nail, than 5cm distal tibia fragments stabilized with standard nail.

Dogra et al retrospectively studied that approximately 1 cm of the nail end distal to the lowermost locking hole was removed and their functionl outcome was good.

Court et al showed that in low diameter undreamed nails high rate of malunion related to high number of screw breakages.

Krag et al showed that outer diameter and the pitch of the screws primarly affects the pull out strength .

Gaebler et al demonstrated the fatigue strength of locking screws, in small diameter tibial nails.he showed that 20% increase in the screw diameter adds additional 25 to 70% in fatigue strength

EVOLUTION OF THE LOCKING COMPRESSION PLATE

1890-1910	Lane (Open Fracture treatment) W.Sherman (Metal alloys) Lambotte's series Hey-Groves (Locking Screws) Lane plate
1950-1960	Danis -Osteosynthesis
1980	Internal fixator system -Polish Surgeon
1990-2000	Blatter and weber -Wave plate Schuhli nut Minimally invasive percutaneous osteosynthesis Locking Plate
2000-2010	minimally invasive percutaneous plate osteosynthesis and locking system

DEVELOPMENT OF LOCKING COMPRESSION PLATE

Tremendous advances in plating have been made in the the internal fixation of fractures.

In 1980 the polish surgeon first developed the internal fixator system.By evaluating the number of principles[18] the base of the implant design was made out,

- To the plate, the screw should be fixed.
- For stable fixation, the number of screws should be optimal.
- Between the bone and the plate the compression should be eliminated.
- The interfragmentary compression and the plate stability should be preserved.

The following devices lead to the development of the so called locked internal fixator.

1. ***Schuhli locked plate:*** This was developed by J. Mast. Schuhli, keep the plate away from the bone. It has three sharp projections. As it makes less direct contact between the plate and bone it acts as a low profile internal fixator. In addition, if in

case of missing cortical bone, Schuhli[18] nuts can act as proximal cortices and bi cortical fixation is feasible.[23]

2. ***Point contact fixator (PC-FIX):*** These devices preserve the blood supply of the periosteum by point contact. These fixators are secured by unicortically inserted screws and hence have minimal contact. The tapered head of the screw ensures that it lodges firmly in the plate hole and provides the required angular stability. PC-FIX was the first plate in which angular stability was achieved. PC-FIX was the basis for the further development of LISS

3. The angled blade plate, devised by AO is the strongest implant providing improved stability.

4. Interlocking nail used in comminuted diaphyseal fracture proved that open anatomical reduction of the fragment is not necessary and close treatment of the comminuted fragments with splinting by intramedullary nail produces abundant callus and solid healing. These four developments, Schuhli nut, point contact plate, fixed angled blade plate and locked intramedullary nail naturally lead to the development of internal fixator by locked head plate.

5. During the last decade, bridge plating and less invasive and minimally invasive surgery were developed.

6. Finally ***M. Wagner and R. Frigg*** developed the locking compression plate (LCP)[19,20,21], with combi holes and functionality of both locking and conventional plate. This development revolutionized operative fracture fixation of distal tibial fractures.

RULES OF SCREW PLACEMENT IN A LOCKING COMPRESSION PLATE[8,22]

1) Conventional screws are inserted before any locking screws.

2) Conventional screws will bring the plate closer to the bone.

3) Conventional screws can be used to lag fracture fragment through plate or individually.

4) Locking screws will not reduce the bone to the plate.

5) Locking screws form a fixed angle construct with plate to increase the stability in osteoporotic bone.

6) Lag before lock. After placing locking screws no additional compression or reduction of the fragments are possible.

Locking screws should be placed as the final step of plate osteo synthesis

ADVANTAGES OF LOCKED INTERNAL FIXATOR[8,22]

1) As they require no precontouring, primary displacement does not occur.

2) Internal fixator is a biological plate and is an elastic stable fixation. Therefore, natural secondary healing allows abundant callus and faster healing at the fracture site.

3) The screws are incapable of sliding, togging or becoming dislodging. Therefore there is no loss of secondary reduction.

4) Locking the screws ensures angular, as well as axial stability and eliminates unwanted movement of the screws.

5) Blood supply to the bone is preserved as the plate is away from bone.

6) Ideally suited in osteoporotic bones, with less pull-out of screws.

7) Screws with multiple angular stability in the epiphyseal and metaphyseal fragments make the construct very stable.

8) Locked internal fixators are noncontact plates, hence no disturbances in periosteal blood supply, and therefore there is no risk of refracture after removal of plate.

9) No need to contour the plate and also no need to the compress the plate to bone.

10) Also there is no need for reconstruction of the opposite deficient cortex.

11) Poly axial screws have an advantage. It can be angled in any desired direction.

ADVANTAGES OF MULTIDIRECTIONAL LOCKED NAILING

- Minimal soft tissue stripping[17,23]
- Minimally invasive[24-28]
- Dynamisation can be done
- Better axial stability[29]
- Early mobilisation can be initiated as it is a weight bearing device[30,31,32].
- Extra osseous blood supply[33] is preserved.
- Operating time is shorter[34].

Multi directional inter locking screw fixation provides good results in the AO type of 43 A1,43 A2,43 A3 fracture type according to various literature [29,31,33,35,36]

NUMBER OF INTERLOCKING SCREWS

For fracture stability, there should be minimum two screws for good fixation.In distal tibial fractures three locking screws[29] provides better fixation than two screw fixations.In more than three screws fixation there is no biomechanical advantage.

Soft tissue injury associated with distal tibial fractures:

It is common as the soft tissue coverage is minimal.In high energy fractures when the impact absorption exceeds the thresh hold,there is a rapid transmission of destructive residual forces to the thin cover of adjacent soft tissue resulting in soft tissue injury

Extensive contusions ,severe muscular damage, fracture blisters are often seen in closed tibial fractures.Subsequently the incidence of the open fracture is so high as 16% to 47%[37-40] of all distal tibial fractures.

Therefore in such fracture pattern the multi directional interlocking nailing plays a major role in better fixation as it is minimally invasive and causes less soft tissue damage .

FIBULAR PLATING

Associated fibular fractures are common in distal tibial fractures,when the fracture lies within 7 cm from the tip of lateral malleoli it should be fixed, for better biomechanical stability[41], better alignment of tibia for nailing and to correct the rotational alignment .

Fibular fracture when it involves at the syndesmotic level it should be fixed first for better stability ,as the literature review says that the fibular fracture fixation[42] provides better stability than the cases treated without fibular fixation[43].

For the best results in fracture fixation, the fibula should be fixed prior to the tibia fixation.

WEIGHT BEARING

Immediate weight bearing can be started in the fractures fixed with nailing.In cases when the fibular fracture addressed along with tibial fracture delayed weight bearing upto one month[44] is recommended as the literature review.

Acceptable radiological criteria:

At the end of union,the acceptability of reduction can be measured by means of drawing radiological lines in the

anteroposterior and lateral films .The varus and the valgus angulation is measured in the anteroposterior films and the anteroposterior angulation in the lateral film. The acceptable radiological criteria given by various literatures[45-48] are as follows,

Valgus/varus angulation < 10 degree.

Anteroposterior angulation< 10 degree.

ANATOMY

Tibial bone is much stronger than fibular bone and is placed medial and it is the larger bone in the leg . It corresponds to the radius of the upper limb. Tibial bone[49] has an upper end, shaft and a lower end. Its shaft is prismoid in cross section with expaned ends, the smaller distal end having a strong medial malleolus projecting distally.

PROXIMAL END

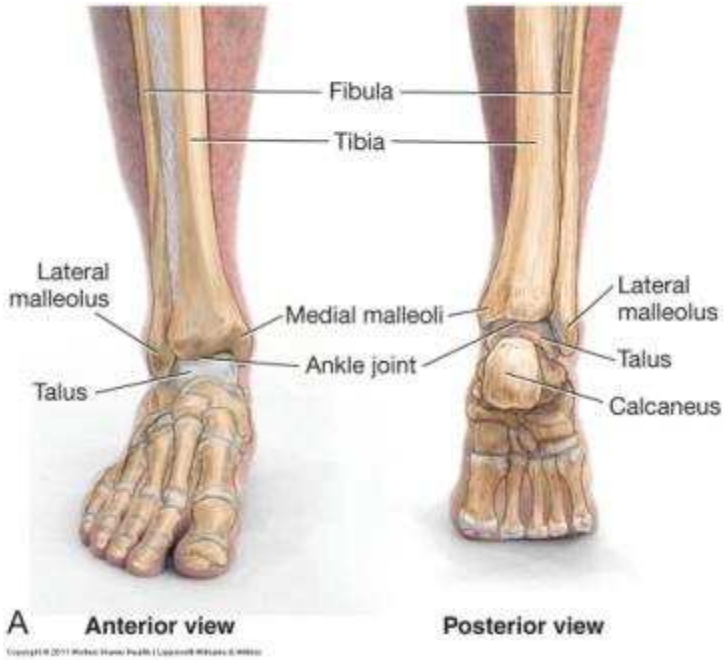
The proximal end expanded transversly is a bearing surface for body weight transmitted through the femur. It has amassive lateral and medial condyles, tibial tuberosity ,and intercondylar area.

SHAFT

The shaft is triangular in cross sectiron.It has three surfaces and the three borders.It has lateral, medial and posterior surfaces separated by anterior ,lateral(interosseous) and medial border.

DISTAL END

The distal end of tibia is slightly expanded. It has five surfaces namely anterior,, posterior, lateral , medial and distal surfaces.It projects inferomedially as medial malleolus.



MEDIAL SURFACE

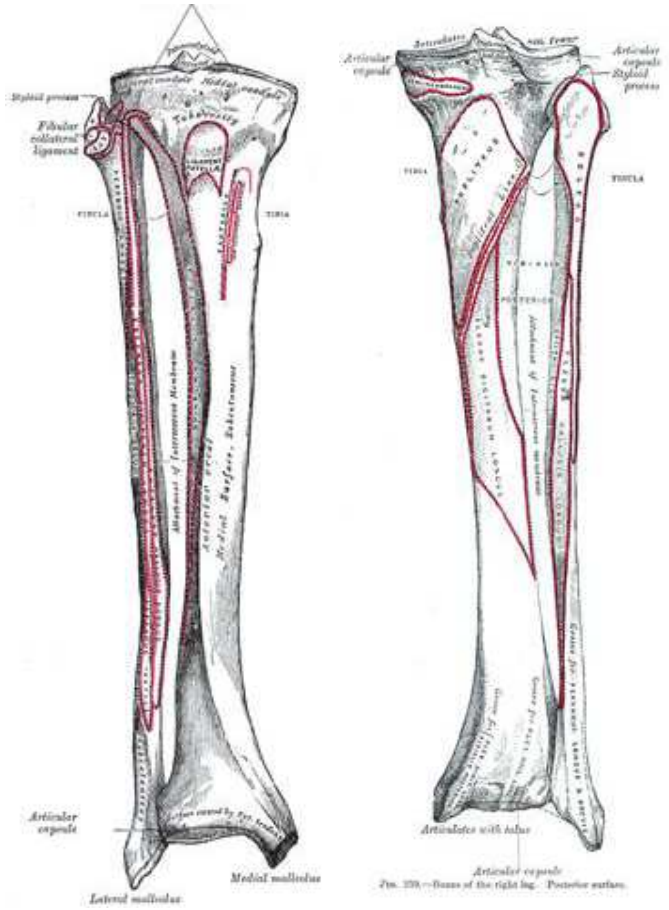
It is smooth and continous above and below with the medial surfaces of the shaft and malleolus is subcutaneous and visible.

POSTERIOR SURFACE

It is crossed near its medial end by a nearly vertical,but slightly oblique groove[73] usually conspicuous extending to the posterior surface of the malleolus.Elsewhere it is smooth and continous with the posterior surface.

LATERAL SURFACE

It is the triangular fibular notch, beyond by ligaments to the fibula its anterior and posterior and anterior edges project and proximallyconverge to the interosseous border.

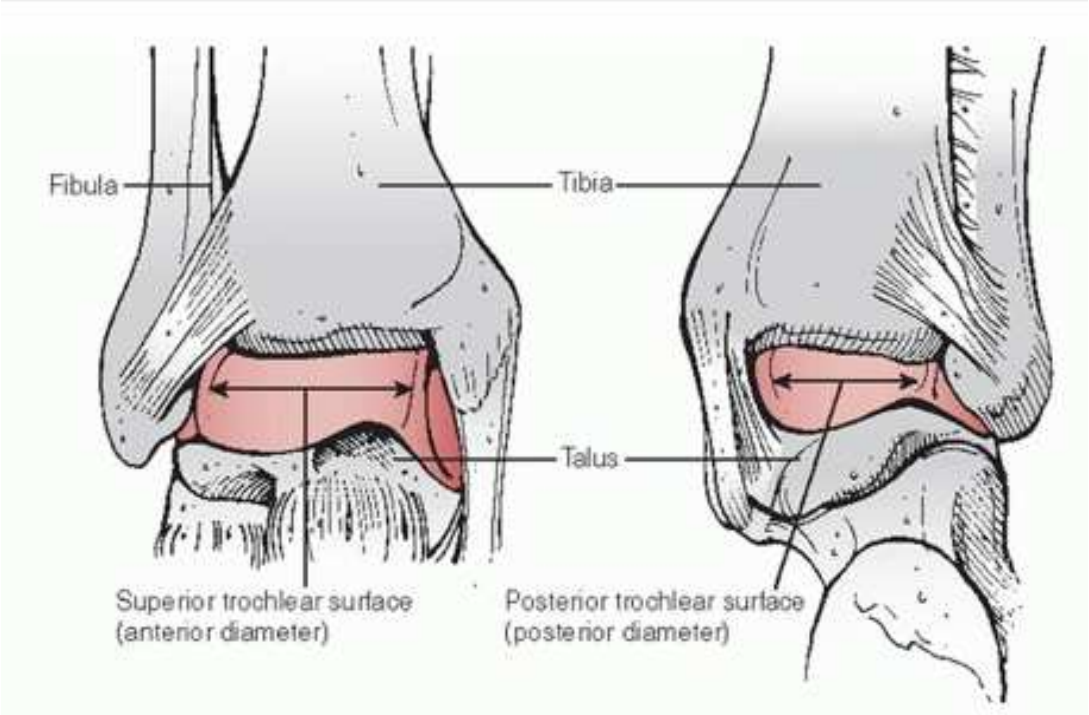


There is a notch in the floor which is roughened by an interosseous ligament proximally but is smooth distally and sometimes covered by an articular cartilage.

Distal surface:

The distal tibial surface, articulating with the talus is wider in front, concave sagitally and slightly transversely convex .medially it is continous into the malleolar articular surface.This articular surface may extend into the groove separating it from the shafts anterior surface,such extension medial or lateral or both surface are squatting facets, articulating with the reciprocal talar facets in extreme dorsiflexion.

ANTERIOR AND POSTERIOR VIEW



MEDIAL MALLEOLUS*:*

The medial malleolus is short and thick, has a smooth lateral surface with a cresentic facet articulating with the medial talar surface.The distal border is pointed anteriorly and depressed posteriorly.

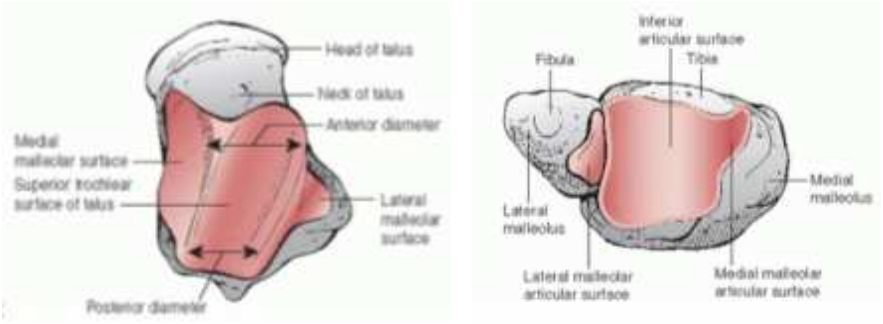
Tibial bone acts as the weight bearing bone[49] of the leg and their subcutaneous location in the anterior and medial aspect makes it vulnerable to open factures.

Distal tibia ,fibula and the talus forms the osseous anatomy of the ankle joint.

When the distal ends of the tibia and the fibula meets the talus at the superior dome the ankle mortise is formed.

The medial end of the distal tibia there is a bony projection called medial malleolus.

SUPERIOR VIEW UNDERSURFACE VIEW



The articular surface of medial malleoli articulates with the medial articular portion of talar body and it is oriented perpendicular to the tibial plafond.

The lateral malleolus ,the distal end of fibula articulates with the lateral articular portion of the talar body.The tibio fibular syndesmosis is formed by the articulation of the distal tibia with the distal fibula.

Regarding the anatomic axis of tibia, the tibial plafond is oriented in slight valgus in the frontal plane (2 degrees), and the anatomic axis passes just medial to midline of the talus. The tibial plafond is slightly extended in sagittal plane (approximating 5 to 10 degrees) and the mid-diaphyseal line of the tibia passes through the lateral process of the talus.

Clinical anatomy of the ligamentous attachment at the ankle joint[73] helps in better understanding of the displacement and fracture anatomy.

The concave surface irregular on the lateral aspect of tibia meets the convex surface of the medial aspect of the distal fibula to form the distal tibiofibular syndesmosis. The distal tibiofibular syndesmosis components include the strong interosseous tibiofibular ligament,the posterior tibiofibular ligament,the anterior tibiofibular ligament.

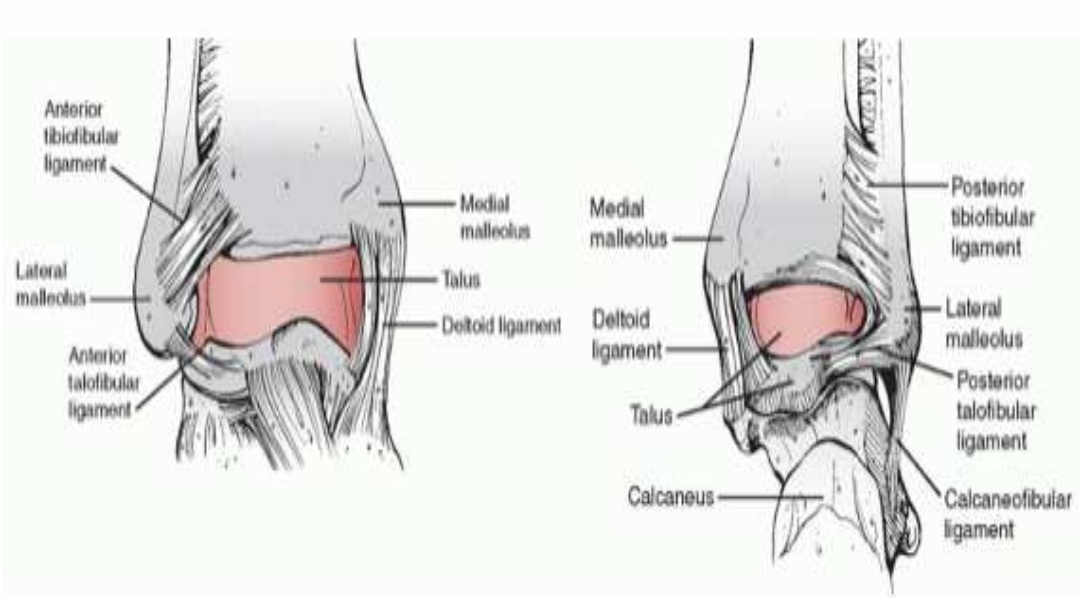
The posterior tibiofibular ligament has deep and superficial ligaments and the deep ligament is called transverse tibiofibular ligament.

The medial collateral ligament is also known as the deltoid ligament.it has two layers the superficial and deep.There are three attachments distally to the superficial layer, namely the superficial tibiotalar ligaments,tibio navicular ligament and the tibiocalcaneal ligament.

The deep layer of the deltoid ligament consists of the anterior and posterior tibio talar ligaments.The posterior tibiotalar ligament is clinically important and is the strongest ligament. It originates

from posterior colliculus and travels posterolaterally and inserts to the entire nonarticular medial surface of the talus.

LIGAMENTOUS STRUCTURES

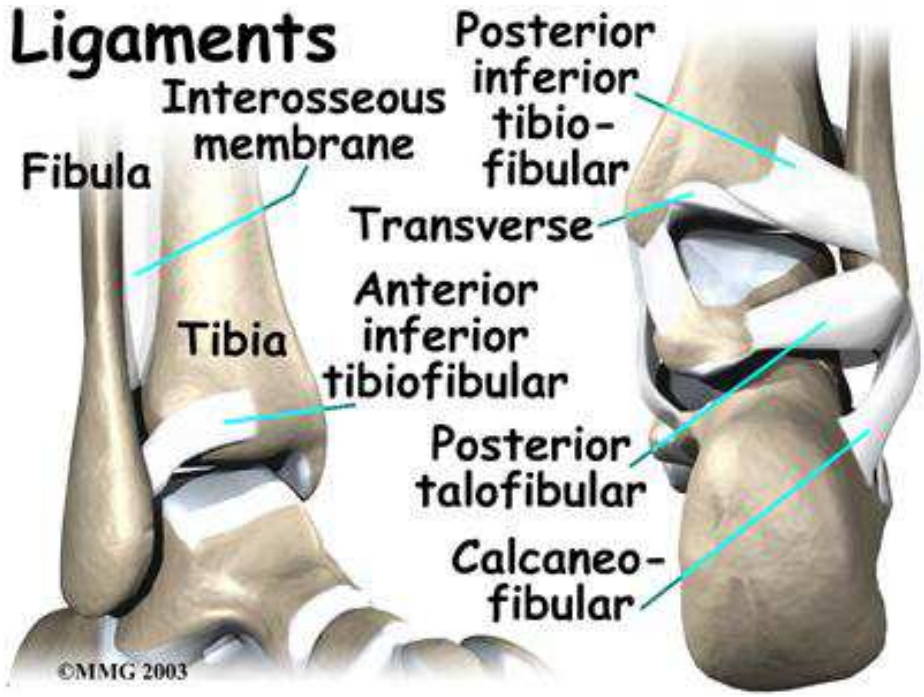


For uncomplicated and safe internervous plane, basic knowledge about muscular and tendinous anatomy of distal tibia is required. Tibia has four muscular[49] compartments. They are Anterior, Medial, Superficial and Deep Posterior compartments.

The contents of anterior tibial compartment from medial to lateral are the Tibialis anterior, Extensor hallucis longus, Extensor digitorum longus and peroneus tertius muscles. These muscle receive nerve supply from the deep peroneal nerve. Neurovascular bundle of anterior tibial artery and deep peroneal nerve runs between extensor hallucis longus and extensor digitorum longus.

The anterior compartment is relatively unyielding compartment bounded by the tibia medially, fibula laterally and interosseous membrane posteriorly and tough crural fascia anteriorly.

The lateral compartment of the leg contains the peroneus longus and peroneus brevis muscles. These muscles are innervated by superficial peroneal nerve which runs in the intermuscular septum between peroneal muscles and extensor digitorum longus. In the distal third of the leg, the superficial peroneal nerve is purely sensory, which pierces the lateral compartmental fascia, and travels in the subcutaneous fascia from posterior to anterior, typically encountered during the anterolateral surgical exposure.



A posterior septum intervenes between the superficial and deep posterior compartments. The superficial posterior compartment[49] contains the gastrocnemius, soleus and plantaris muscle. It also serves as a source for local muscle flap for covering soft tissue defects which are encountered with internal fixation of tibial pilon fractures. These muscles are innervated by the tibial nerve.

The deep posterior compartment is largely tendinous and includes Tibialis posterior, Flexor digitorum longus and the Flexor hallucis longus muscle. All these muscles are innervated by the tibial.

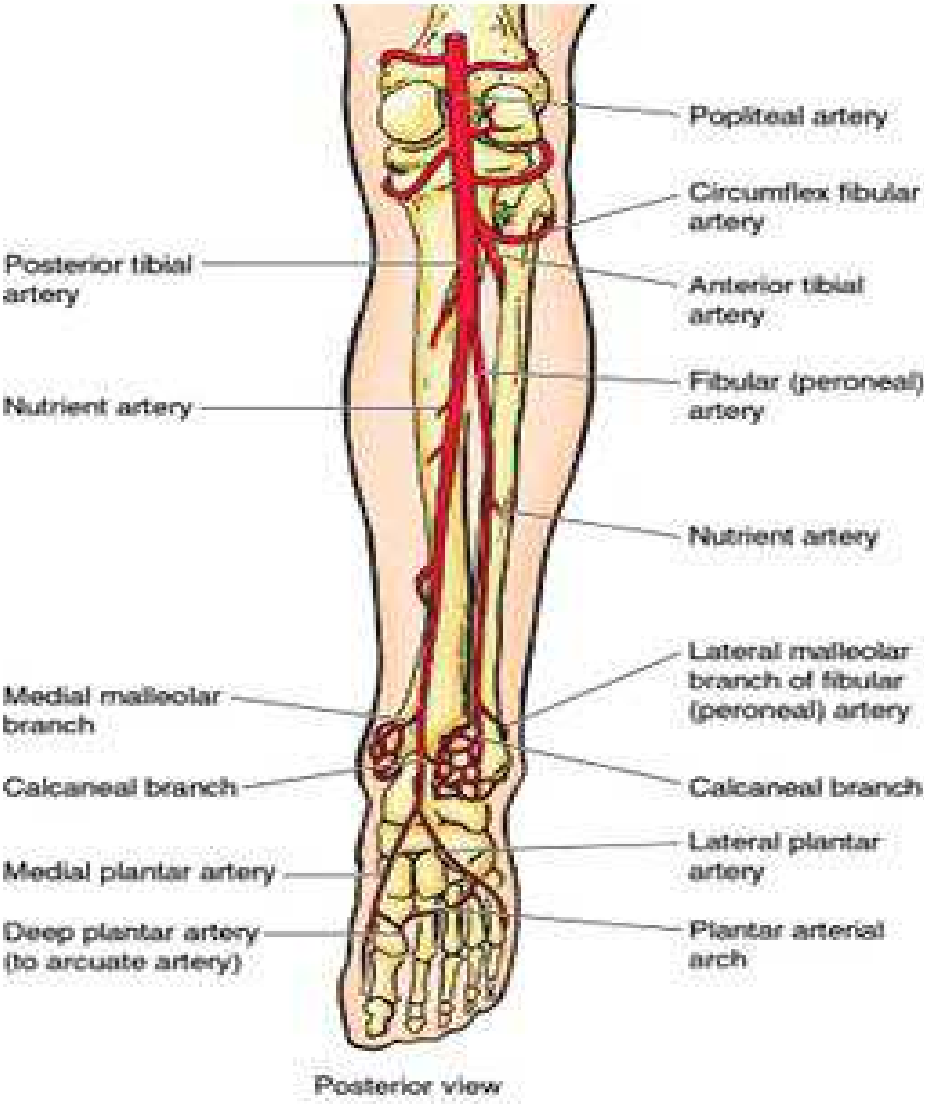
BLOOD SUPPLY

The periosteal vessel and nutrient artery supplies the distal tibia.the nutrient artery originates from the posterior tibial artery. Three ascending and one descending branches arises from the nutrient artery .

In trivial injury to the distal tibia, this nutrient artery may be injured.To prevent avascularity, the soft tissue envelope should be preserved in the distal tibia as it is the only source of blood supply to the periostium. The anterior tibial artery[49] is divided from the popliteal artery and provides periosteal blood supply along its course throughout the interosseous membrane.

Blood supply to the distal tibia become more compromised due to underlying soft tissue injury in case of distal tibial fractures.Hence non union, poor wound healing, hard ware problems were encountered while doing plate osteosynthesis.

5.40. Arteries of the knee, leg, and foot.



BIOMECHANICS OF ANKLE JOINT

- The normal range of motion of the ankle in dorsiflexion is 30 degree, and in plantar flexion it is 45 degree.
- Motion analysis studies reveal that a minimum of 10 degree of dorsiflexion and 20 degree of plantar flexion are required for normal gait.
- The axis of flexion of the ankle runs between the distal aspect of the two malleoli, which is externally rotated 20 degree compared with the knee axis
- A lateral talar shift of 1mm will decrease surface contact by 40%,a 3mm shift results in more than 60% decrease
- Disruption of the syndesmotic ligaments may result in decreased tibio fibular overlap.Syndesmotic disruption associated with fibula fracture may be associated with a 2 to 3mm lateral talar shift even with an intact deep deltoid ligament.

OSSIFICATION

The tibia ossifies from one primary and two secondary centers.the primary centers appears in the shaft during the seventh

weak of the intra uterine life.The secondary centers for the upper end appears just before birth and fuses with the shaft at 16-18 years.the upper epiphysis usually includes the tibial tuberosity.

A secondary centers for the lower end, appearing during the first year forms the medial malleolus by the seventh year and fuses with the shaft by the 15-17 years.Separate secondary centers may appear for the medial maleolus and tibial tuberosity.

AO/OTA CLASSIFICATION

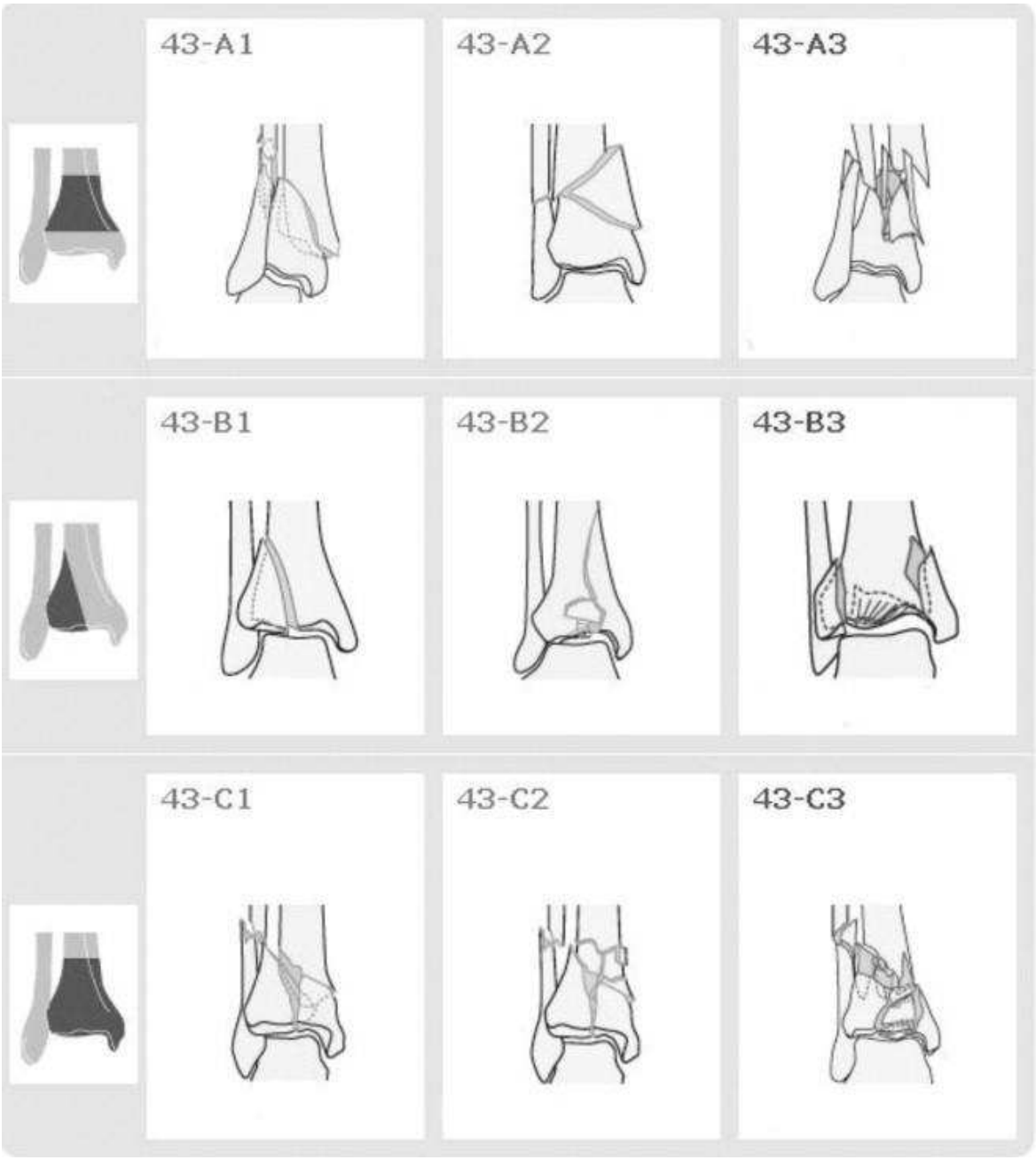
The AO/OTA classification system provides a comprehensive description of distal tibial fractures. The distal tibia is assigned numeric code of 43. Injuries of the tibial plafond are then categorized as extra-articular (43 type A), partial articular (43type B) and total articular (43type C).

AO Type A – fractures are extra-articular distal tibial fractures

A1 – Metaphyseal simple

A2 – Metaphyseal wedge

A3 – Metaphyseal complex



AO CLASSIFICATION FOR DISTAL TIBIAL FRACTURES

Soft Tissue Injury Classification

The recognition of the soft tissue injury associated with tibial plafond fractures has resulted in the evolution of their surgical treatment. A thorough evaluation of the soft tissue envelope and surgeon's experience and judgment remains the mainstay. The soft

tissue injury classification system of Tscherne and Goetzen is subjective and grades soft tissue injuries of closed fractures into one of 4 categories, organized from 0 to 3.

Grade 0-Injuries from indirect forces with negligible soft tissue damage.

Grade 1 Closed fracture caused by low to moderate energy mechanisms with contusions of soft tissues overlying the fracture.

Grade 2 Significant muscle contusion ,contaminated deep skin abrasion with moderate to severe energy mechanisms and skeletal injury.

Grade 3 Extensive crushing of soft tissues, with subcutaneous tissue avulsion injury with arterial disruption or estabilished compartment syndrome

MATERIALS AND METHOD

The present study was conducted between August 2013 to September 2014 in the Institute of Orthopaedics and Traumatology, Madras Medical College, Rajiv Gandhi Government General Hospital, Chennai-3 by retrospectively and prospectively.

SELECTION CRITERIA

1) Adult patient more than 18 years of age and less than 70 yrs of age.

2) Closed fractures and grade I compound fracturesof distal tibial fractures(43-A1,43-A2,43-A3 OF AO tybe) without intra articular extension.

EXCLUSION CRITERIA

- Age less than 18 years and more than 70 yrs
- Grade II ,III Compound fractures of distal tibia.
- Fractures with intra articular extension.

A total of 24 cases (12 males and 12 females) with distal tibial fractures were used for our study. For nail age group ranged from 33-55 years(mean of 43.08) and for the plating group the age ranged from 27 to 60years(mean of47.08).

CLINICAL EVALUATION

Patient presenting with lower extremity injury are evaluated for distal tibial fractures.After stabilising the patient general condition injured ankle examination is carried out.Proper history taking is necessary as it gives clue to asses the mechanism of injury which indirectly assess the velocity of injury.

Comorbid illness should be elicited as a part of history taking because it is considered as a major factor to determine the functional outcome of operative intervention.

On examination the swelling, deformity noted on inspection and tenderness, abnormal mobility,crepitus noted on palpation indicates the signs of fracture

Skin status evaluation is more important and note circumferentially around the ankle for the open wound,bruises and soft tissue swelling.

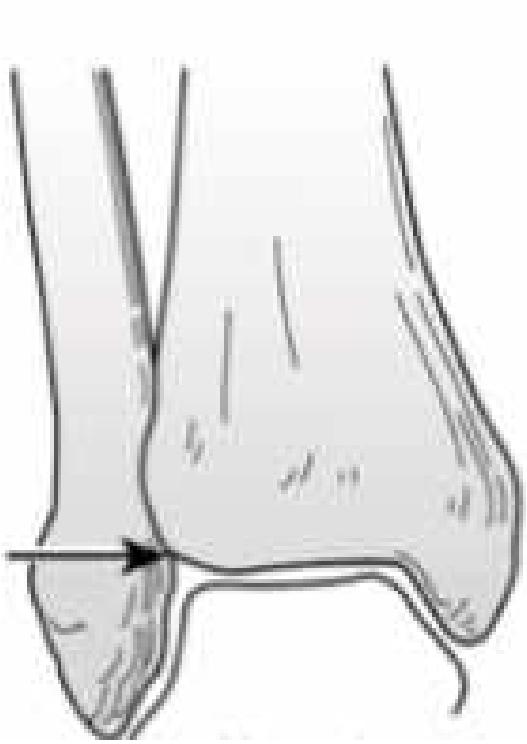
Development of skin blisters,limb edema,local rise of skin temperature should be looked for .In the initial period of injury, periodically moniter the capillary refill of the involved extremity.Functions of the extensor tendon and thorough neuro vascular examination should be carried out.

Distal tibiofibular syndesmotic injury and the ipsilateral knee joint injury should be ruled out.

RADIOLOGICAL EVALUATION

Plain Radiographs[50,51]

The radiographic evaluation must include the entire tibia with visualization of the ankle and knee joints.Anteroposterior (AP), mortise, and lateral view of injured ankle joint are taken. Additional radiographs include 45 degree oblique views to identify and assess articular involvement and anatomic details of fractures affecting the distal tibial metaphysis.

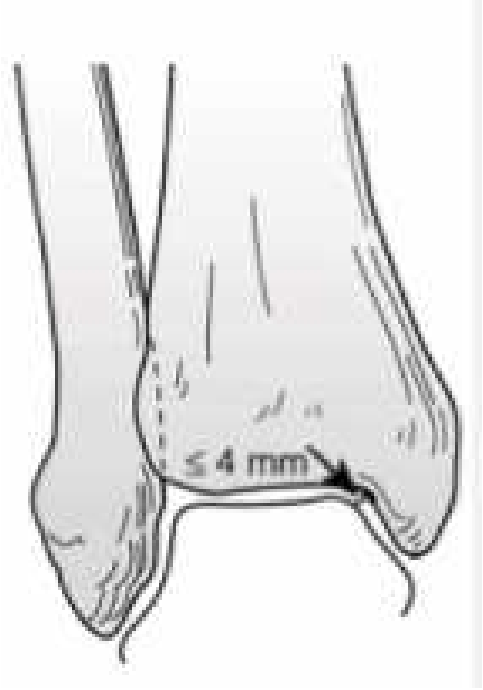


Mortise View[50,51]

It is taken by internally rotating the leg up to 15 degrees, so that x-ray beam passes perpendicular to the intermalleolar line. This view helps in evaluating the lateral talar shift (the medial clear space), fibular shortening and fibular rotation (tibiofibular line).

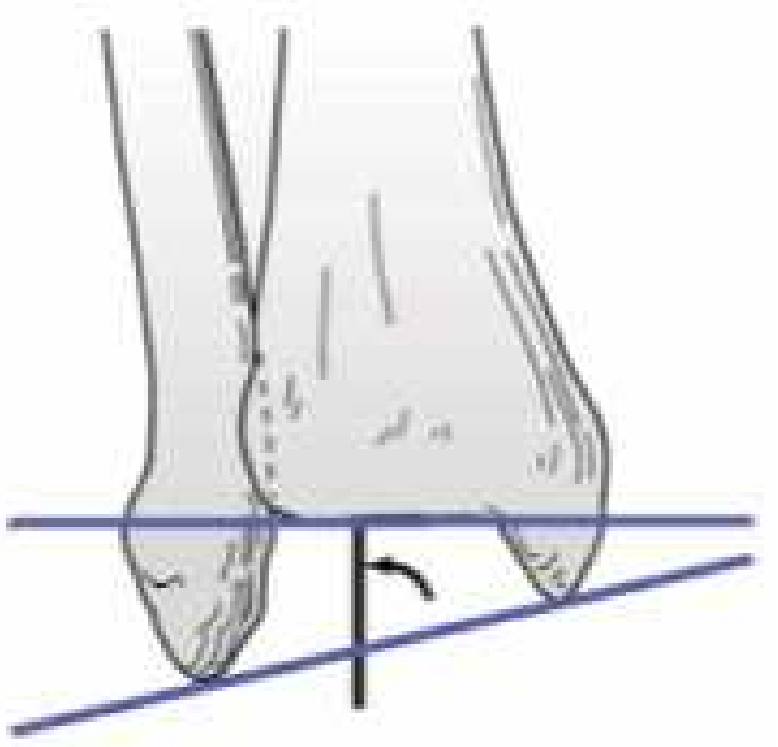
Medial Clear Space[50,51]

On mortise view, the distance between the medial border of the talus and the lateral border of the medial malleolus is called medial clear space. It should be equal to the superior clear space which is the distance between the talus and the distal tibia. A space greater than 4 mm is considered abnormal and indicates a lateral shift of the talus.



The Talocrural Angle

The talocrural angle is measured between a line perpendicular to the tibial plafond and a line connecting the tips of the medial and lateral malleoli. Normal range is 83 ± 4 degrees or a deviation from the talocrural angle measurement on the contralateral side. It helps in measuring the fibular length.



EVALUATION OF SYNDESMOSIS

The simplest method is to measure the distance between the medial wall of the fibula and incisural surface of the tibia. This tibiofibular clear space should be less than 6 mm on both AP and Mortise views.The tibiofibula overlap of less than 10mm is abnormal and implies syndesmotic injury.

TIBIOFIBULAR LINE

It is formed by sub chondral surface of distal tibia and medial aspect of the fibula. It should be continuous indicating that the articular surface of the talus is congruous with that of distal fibula. Any disruption indicates shortening, rotation and lateral displacement of the lateral malleolus and also syndesmotic ligaments disruption.

TALAR TILT

A difference in width of the medial and lateral aspects of the superior joint space of more than 2mm is abnormal and indicates medial or lateral disruption

COMPUTED TOMOGRAPHY

The computed tomography(CT) Scans helps to delineate bony anatomy,especially in patients with plafond injuries

MAGNETIC RESONANCE IMAGING

The magnetic resonance imaging(MRI) may be used for assessing occult cartilaginous,ligamentous,or tendinous injuries

METHODS OF TREATMENT

NON-OPERATIVE TREATMENT

Long leg plaster casting is reserved for non-displaced fractures after careful examination of both anteroposterior view and lateral views.Non operative treatment is adopted for those who have absolute or relative contraindication for surgical management.Articular displacement and metaphyseal fractures of distal tibia are not included for non operative management.

OPERATIVE TREATMENT

The principles of surgical treatment are to maintain axial alignment and proper length,anatomic restoration of articular surface, early mobilisation of joints and stable fixation of fractures.The velocity of injury,fracture pattern,the age of the patient,condition of soft tissue injury and comorbid condition like diabetes mellitus,hypertension,peripheral vascular diseases are the determining factors for the operative treatment.

NAIL DESIGN

CHARACTERISTICS OF MULTIDIRECTIONAL LOCKED NAILING :

1) The locking screws can be inserted in three directions namely oblique ,anteroposterior and medio lateral.

2) The distal most screw is about 5mm from the distal end of the nail.

3) Within 4cms from the distal tip of the nail 4 locking screws can be applied for better stability

OPERATIVE TECHNIQUE FOR NAILING

- ❖ Patient in supine position
- ❖ On the radiolucent table
- ❖ Atleast 90 degree knee flexion is required for nail insertion.
- ❖ Fibular fractures within 7 cm from the distal articular surface fixed with one third tubular plate initially.

ENTRY POINT

Saggital plane: mid point of the line joining the articular surface of the tibia and tibial tuberosity.

- ❖ Coronal plane: just medial to the lateral tibial spine.
- ❖ Open the medullary cananl by means of cannulated drill bit or the cannulated awl or the cutter, the medullary canal can be opened over 8 to 10 cms.The posterior cortex should not be breached out at any cost.
- ❖ Serial reaming done upto one size above the desired nail size.
- ❖ confirm the distal end of the nail position by means of C-arm.
- ❖ C arm used in all cases for distal locking screws.
- ❖ Two locking screws applied in the proximal part with the help of jig provided

- Using free hand technique under the c-arm guidance minimum three locking screws applied distally.

- Wound closed in layers and sterile dressing applied

POST OPERATIVE PROTOCOL

- Advised immediate weight bearing as tolerated if fracture reduction was satisfactory. - Immediately after surgery active knee and ankle exercises were started

- Fractures fixed with fibular plating and in communited fractures, non weight bearing was adivesed for one month,later weight bearing as tolerated advocated for next 2 months

- Post operatively parenteral antibiotics given for 10 days.

- Patient discharged after suture removal on 12 th day.

- Patient follow-up done on 45 th day , 3 months, and 6 months

PLATES AND SCREWS

The 3.5 mm Anterolateral Distal tibia LCP[52,53]

Fixation with the 3.5 mm Anterolateral Distal tibia LCP is different from the traditional plate fixation methods of tibial pilon in that the plate is placed on the lateral surface curving anteriorly towards subchondral bone. The technical innovation of locking screws provides the ability to create a fixed angle construct while using familiar AO plating techniques. Locking capability is important for fixed angle constructs in osteopenic bone or multifragmentary fractures where screw purchase is compromised. These plates function similar to multiple, small, angled blade plates. The fixation of this implant can be done by MIPPO technique or open reduction technique.

OPERATIVE TECHNIQUE FOR PLATING

- Patient in supine position
- On the radiolucent table
- A sand bag placed beneath the ipsilateral buttock to prevent rotation.
- The fibula fracture is addressed first to restore the length and it indirectly

PLATE DESIGN

3.5 mm DISTAL TIBIA ANTEROLATERAL LCP

- By posterolateral approach of henry the fibula fracture is reduced and fixed with one third tubular plate osteosynthesis
- Later tibial fracture is fixed by anterolateral approach minimum 7cm gap should be maintain between two incision to prevent skin necrosis.
- surgical approach(posterolateral approach of henry)
- About 12 cm skin incision made proximally from the tip of the lateral malleolus along the posterior margin of the fibula extended anteriorly along the curve of peroneal tendon upto 4cm.

- Lower one third fibula along with the lateral malleolus sub periostally exposed,sheaths of peroneal retinacula incised,the tendons are displaced anteriorly

- Fibular fracture identified ,reduced and fixation is carried out.

FIBULAR FIXATION

The distal and proximal fracture ends are freshened using curette.

Reduction achieved by holding the fragments by reduction forceps**.**

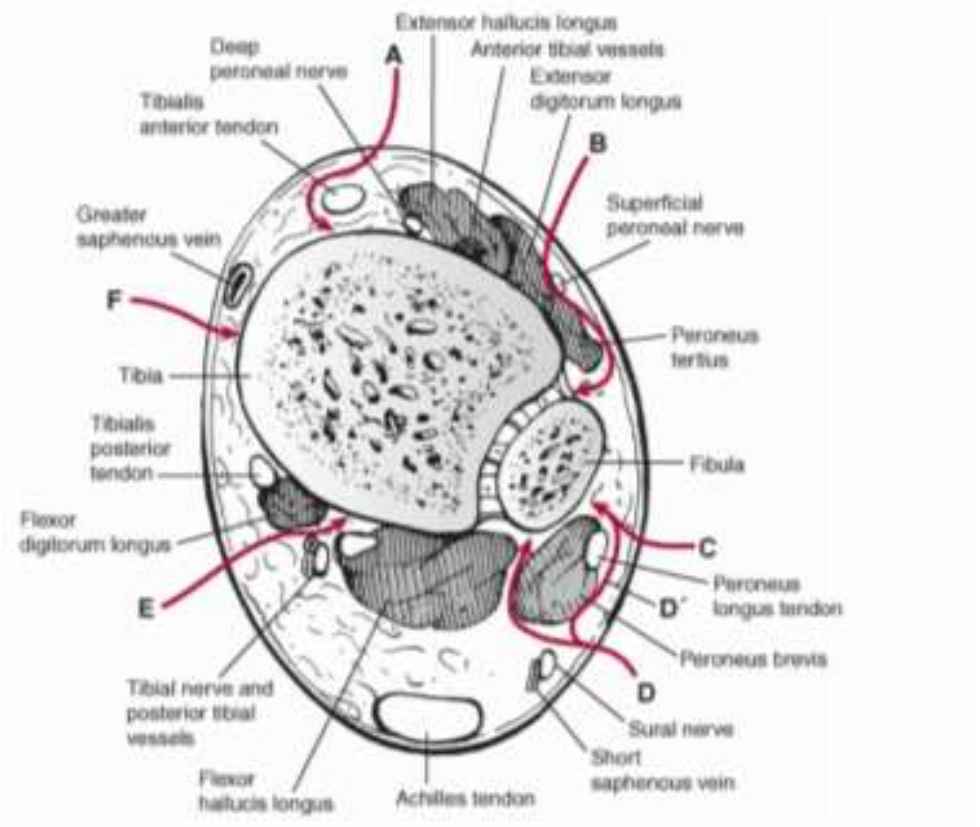
One third tubular plate inserted on the lateral surface of fibula and fixed with 3.5 cortical screw system.

Reduction confirmed by C-arm guidance**.**

Wound wash given and skin closed in layers.

There are five different surgical approaches[54] for exposing the distal tibia they are

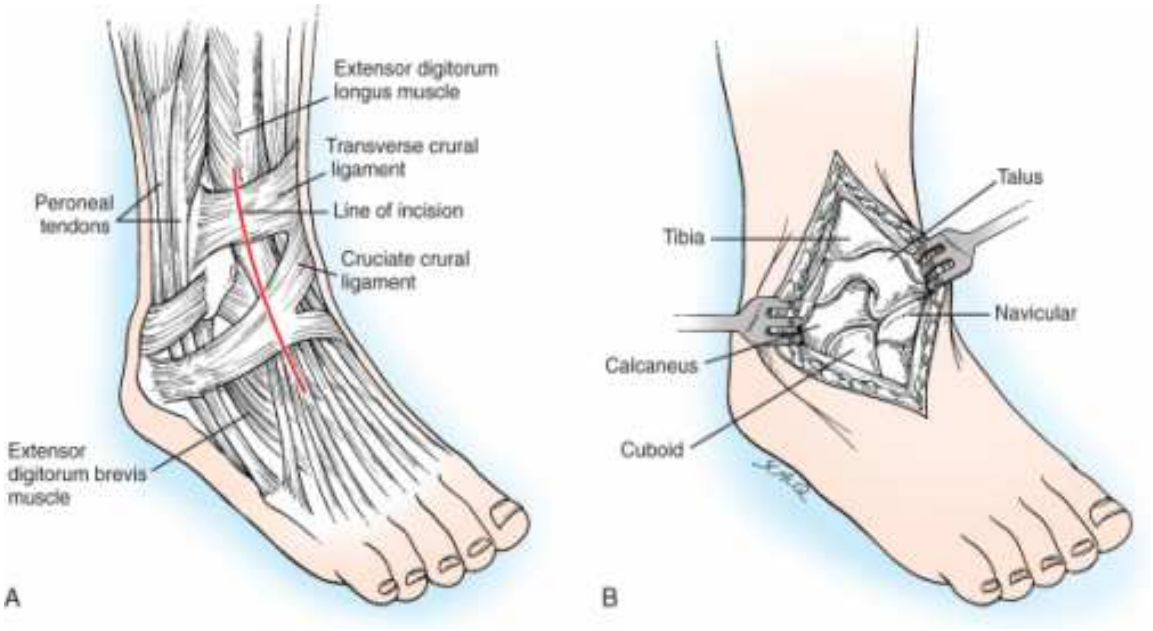
- ❖ Antero lateral
- ❖ Anteromedial
- ❖ Modified antero medial
- ❖ Posterolateral
- ❖ Posteromedial



In our study the antero lateral surgical approach is applied for tibia fixation.

- On the anterolateral aspect of the leg, begin the incision medial to the fibula and about 5cm proximal to the ankle joint.The incision is parallel to the base of the fourth metatarsal distally and in between the tibia and fibula proximally.

- Incise the superior and inferior extensor retinaculae,the fascia,the capsule of the ankle joint and down to the periosteum of the tibia.



-The dorsal cutaneous branch of superficial peroneal nerve should be protected while retracting the edges.

- In the direction of the fibers, the extensor digitorum is divided and reflected distally for better visualisation of the field.

- The dorsalis pedis artery, the extensor tendons, deep peroneal nerve retracted medially and the capsule is incised.

- The anterior compartment tendons including the peroneus tertius are mobilised and retracted medially.

- The anteroposterior and mediolateral axis is checked with the c-arm guidance.

- In some cases the femoral distractor was used to distract the fracture fragment and for reduction purpose placed one on the lateral surface of the tibia and another on the the body of the talus.

- The locking compression plate is slided over the anterior and the lateral aspect of the tibia.

- The offset and the plate position is checked with the c-arm the definitive fixation is started.

- First the conventional screws applied proximally followed by the distal and proximal locking screws.

POST-OPERATIVE PROTOCOL[55]

- In all cases immediately after surgery short leg plaster cast was applied
- After 48 hrs drain was removed.
- Active knee and ankle exercises were strated after 48 hrs
- Walking with support initiated simultaneously with non weight bearing walking
- Suture was removed on the 12th post operative day and the patient discharged
- Follow up radiological and clinical examination were done at 6, 12 ,24 Weeks
- Partial weight bearing allowed once the radiological union was noted.
- After fracture consolidation, full weight bearing was allowed.
- By using the kaikkonen ankle score and lysholm knee scoring system all cases were assessed for the functional outcome

CASE ILLUSTRATION

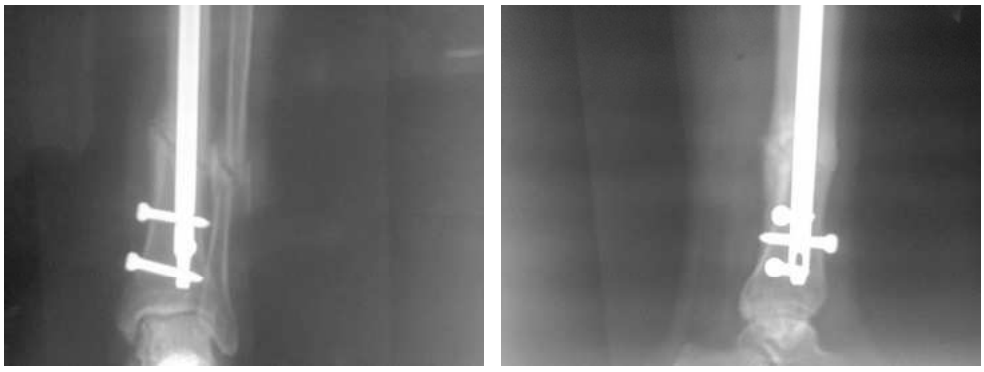
PATIENT-1

Name	:	Rajeswari
Age/ sex	:	55yrs/female
Mode of injury	:	Road traffic accident
Extremity	:	Right
Associated injuries	:	None
Fracture classification	:	Grade I compound 43 A1
Nail size	:	32*8
Number of distal screws	:	1 Ap, 1 Oblique,1 Mediolateral
Reduction	:	Closed
Fibular fixation	:	No
Post operative period	:	Uneventful
Mobilization started	:	Immediate weight bearing
Time of union	:	3 months
Complications	:	None
Ankle range of movements	:	Full
Knee range of movements	:	Full
Ankle score	:	Excellent
Knee score	:	Good

PRE-OP

POST-OP

3 months follow up



6 MONTHS FOLLOW UP




PATIENT-2

Name	:	Rathinam
Age/ sex	:	55yrs/male
Mode of injury	:	Road traffic accident
Extremity	:	Left
Associated injuries	:	None
Fracture classification	:	Grade I compound 43 A1
Nail size	:	32*8
Number of distal screws	:	1 Ap, 1 Oblique,1Mediolateral
Reduction	:	Closed
Fibular fixation	:	No
Post operative period	:	Uneventful
Mobilization started	:	Immediate weight bearing
Time of union	:	3 months
Complications	:	None
Ankle range of movements	:	Full
Knee range of movements	:	Full
Ankle score	:	Excellent
Knee score	:	Good

PRE OP

POST OP

3 months follow up

6 months follow up

PATIENT-3

Name	:	Sundar
Age/ sex	:	52 yrs/male
Mode of injury	:	Road traffic accident
Extremity	:	Left
Associated injuries	:	None
Fracture classification	:	AO type 43 A1
Approach	:	Anterolateral
Post operative period	:	Uneventful
Mobilization started	:	Delayed weight bearing
Time of union	:	5 months
Complications	:	Superficial infection
Ankle range of movements	:	Near normal
Knee range of movements	:	Full
Ankle score	:	Good
Knee score	:	Excellent

Pre operative x-rays

Post operative x-rays

6 months follow up

PATIENT-4

Name	:	Gunaseker
Age/ sex	:	27yrs/male
Mode of injury	:	Road traffic accident
Extremity	:	Right
Fracture classification	:	Grade I compound 43 A3
Approach	:	Antero medial approach
Post operative period	:	Uneventful
Mobilization started	:	Delahed weight bearing
Time of union	:	6 months
Complications	:	None
Ankle range of movements	:	Full
Knee range of movements	:	Full
Ankle score	:	Good
Knee score	:	Good

Pre operative x-rays

Post operative x-rays

4 months follow up

COMPLICATIONS OF MULTIDIRECTIONAL INTERLOCKING INTRAMEDULLARY NAILING

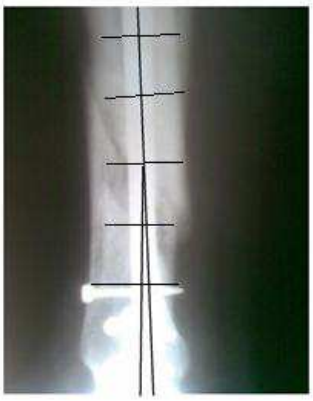
Case: 65/ M with 41A2 type of Grade I compound distal tibia fracture. Closed interlocking intramedullary nailing with locking with 3 screws (anteroposterior, oblique and transverse) was done.

Pre-operative x-ray AP and lateral

Immediate post operative x-rays

Radiological assessment at 6 months post -operatively

20 degree varus angulation



6 degrees
Anterior angulation

There is a 20 degree varus angulation and a 6 degree anterior angulation at the end of union of distal tibia.

Case:35/ F with fracture distal ¼ tibia fixed with interlocking intramedullary nail locked with 3 screws (Oblique, Anteroposterior and transverse)

There is a 12 degree anterior angulation as seen in the lateral film and a 4 degree valgus angulation in the AP film. There was no rotational malalignment

COMPLICATIONS OF PLATING

In our study the complication we met were 3 cases of wound dehiscence and superficial infection which healed by secondary intention, 1 cases of flap necrosis, 1 cases of nonunion, extensor tendon exposed in 1 case, implant failure in one of the three non union cases.

WOUND DEHISCENCE

IMPLANT EXPOSED

EXPOSED EXTENSOR TENDON

NON UNION AND IMPLANT FAILURE

RESULTS AND OBSERVATION

STATISTICAL METHOD

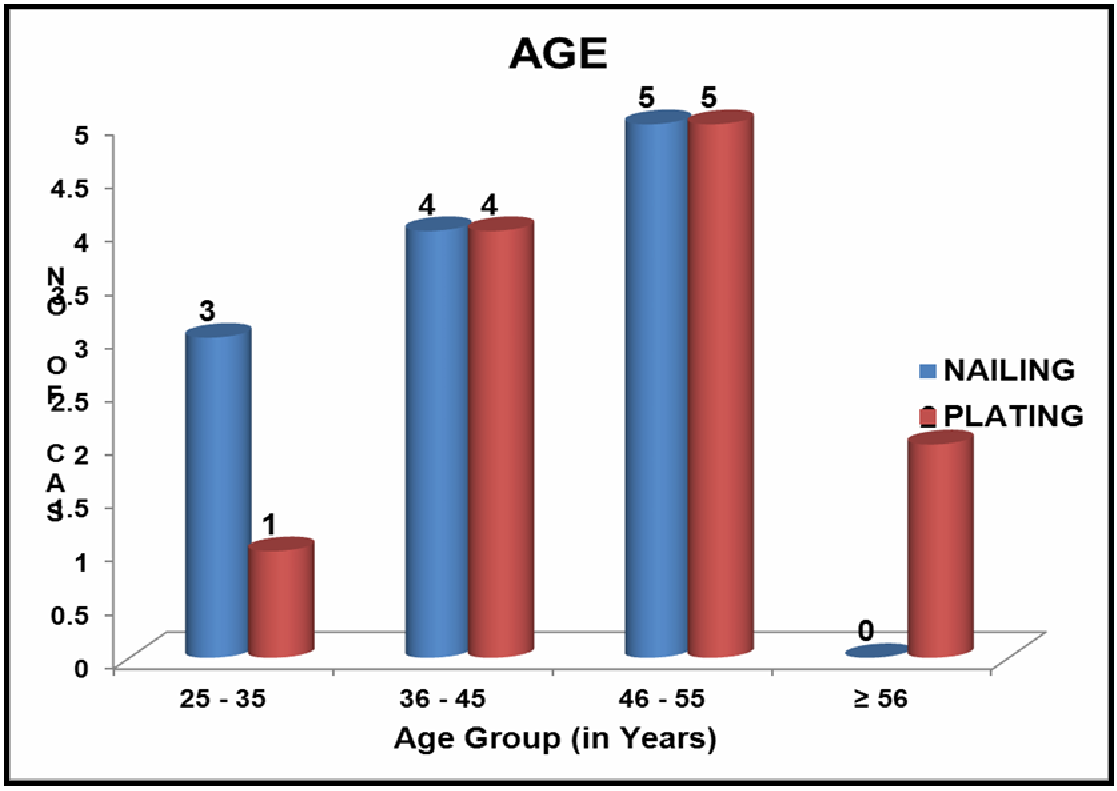
We used SPSS 16.01 Version, paired sample t test, Mc Nemar Chi Square statistical methods for data analysis and statistical significance was accepted when P value is <0.05.

Table-1: Age Distribution

Age Group (in Years)	Nailing		Plating	
	No of Patients (N)	Percentage (%)	No of Patients (N)	Percentage (%)
25 - 35	3	25.00	1	08.30
36 - 45	4	33.30	4	33.30
46 - 55	5	41.70	5	41.70
≥ 56	0	0	2	16.70
TOTAL	12	100	12	100
Range	33 – 55 Years		27 – 60 Years	

Table-2: Mean Age (in Years)

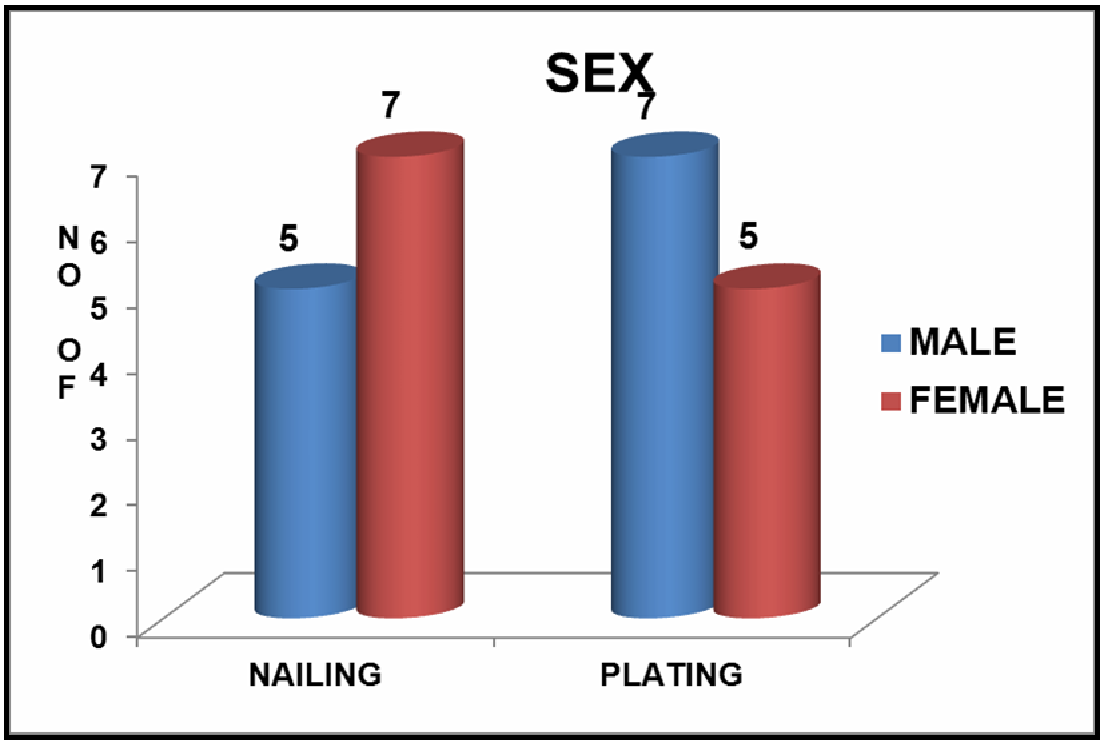
Group	Mean	Standard Deviation
Nailing	43.08	7.80
Plating	47.08	9.68
t-value	1.12	
p-value	0.28	
Significant	Not Significant	



The mean age group for multi directional interlocking nailing ranges from 33-55 years.the mean age group for plating ranges from 27-60 years. The majority of patients of patients were between the age group of 46-55 years for both nail(41.70) and plate group(41.70). The t valve is about 1.12.The p valve is about 0.28 and it is not significant.

Table-3: Sex Distribution

SEX	Nailing		Plating	
	No of Patients (N)	Percentage (%)	No of Patients (N)	Percentage (%)
Male	5	41.70	7	58.30
Female	7	58.30	5	41.70
Total	12	100	12	100
Sex Ratio	42 : 58		58.: 42	



Among 24 patients there were 12 males and 12 females.The sex distribution between males and females in nailing is 42:58 and for plating is 58:42.

Table-4: Nailing & Plating

STATUS	Nailing		Plating	
	No of Patients (N)	Percentage (%)	No of Patients (N)	Percentage (%)
CLOSED	9	75.00	-	
OPEN	3	25.00	12	100
TOTAL	12	100	12	100

Among 24 patients 12 patients selected for nailing and 12 patients selected for plating.In the nailing group 9 patients are operated in the closed method and in 3 patients open reduction and fibular fixation was done.In the plating group open reduction and internal fixation with low profile 3.5 mm locking compression plate for tibia and one third tubular plate for fibular fixation was done.

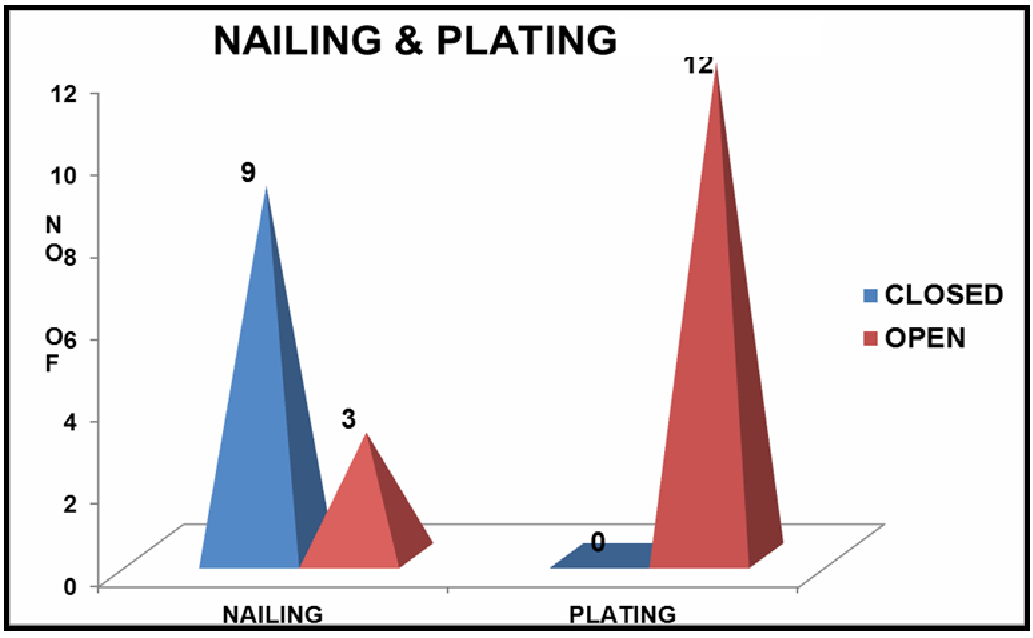
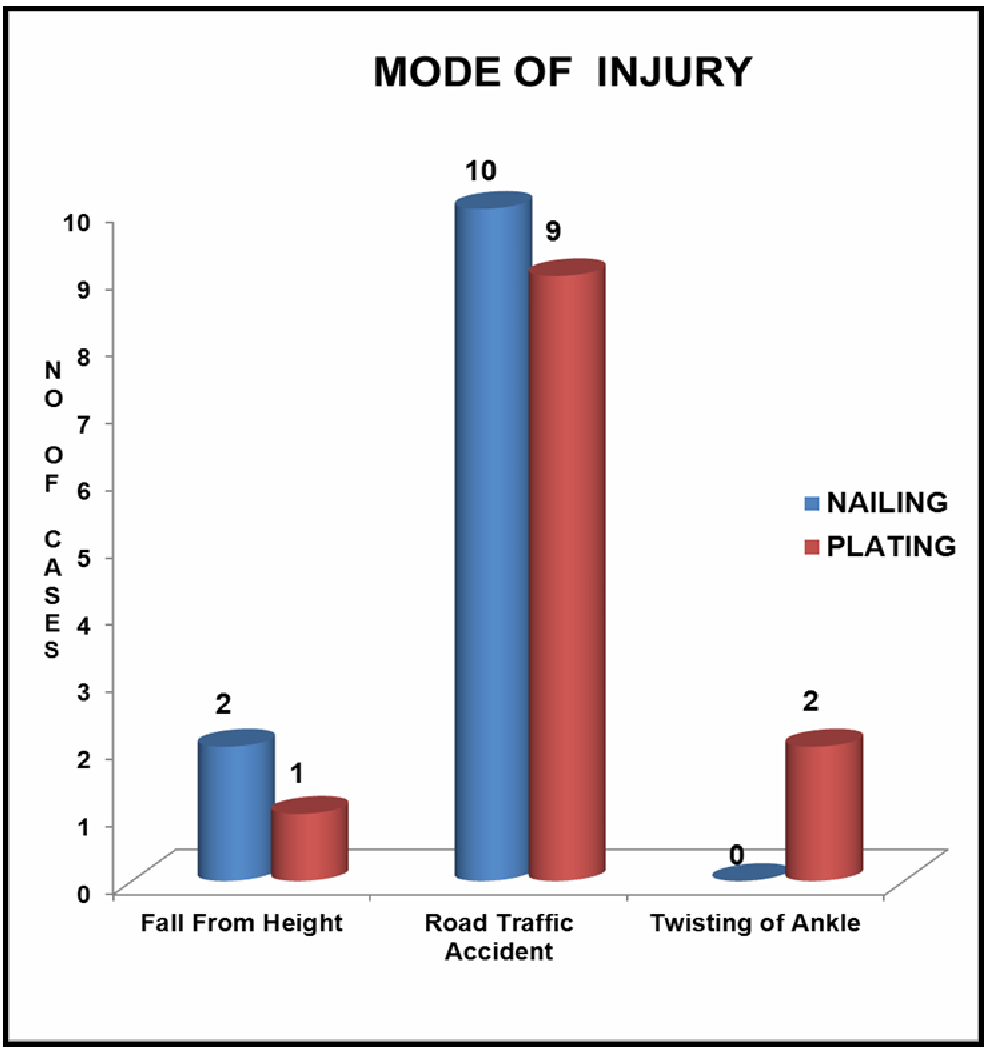


Table-5: Mode of Injury

Mode of Injury	Nailing		Plating	
	No of Patients (N)	**Percentage (%)**	**No of Patients (N)**	**Percentage (%)**
Fall From Height	2	16.70	1	8.30
Road Traffic Accident	10	83.30	9	75.00
Twisting of Ankle	0	0	2	16.70
Total	12	100	12	100
Sex Ratio	41.67 : 58.33		58.33 : 41.67	

Road traffic accident predominates as the the major cause for both nailing and plating.For nailing it is about 83.30% and for platingit is about 75%.Fall from height for nailing is16.70% and for plating is 8.30%.

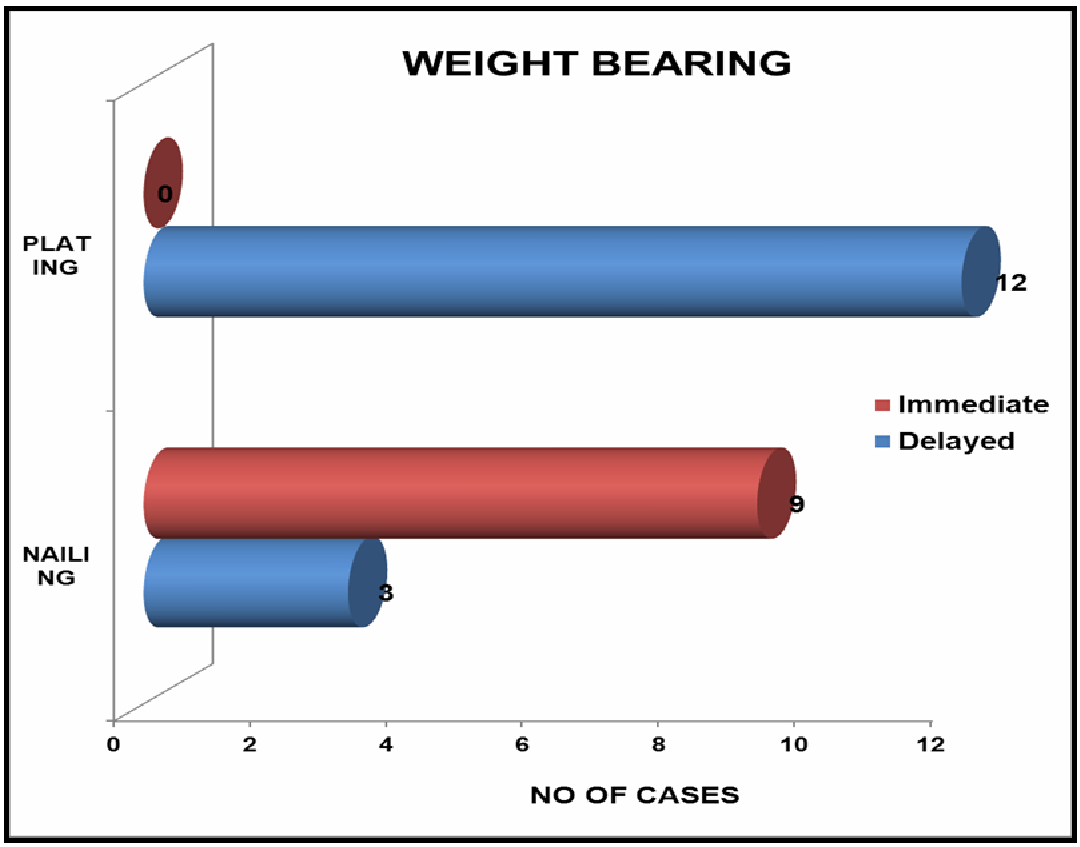


Twisting of ankle is the cause for distal tibial fractures in the old age and it is about 16.70 % in the plate group and zero percent for nail group. The sex ratio for the nailing is 42:58 and for plating is58:42

Table-6 : Weight Bearing

Weight Bearing	Nailing		Plating	
	No of Patients (N)	**Percentage (%)**	**No of Patients (N)**	**Percentage (%)**
Delayed	3	25.00	12	100.00
Immediate	9	75.00	0	0
TOTAL	12	100	12	100
Chi square	14.40			
p-value	0.000			
Significant	Significant			

The weight bearing for the nail group is started after 48 hours as it is load bearing implants and the immediate weight bearing is initiated as patients

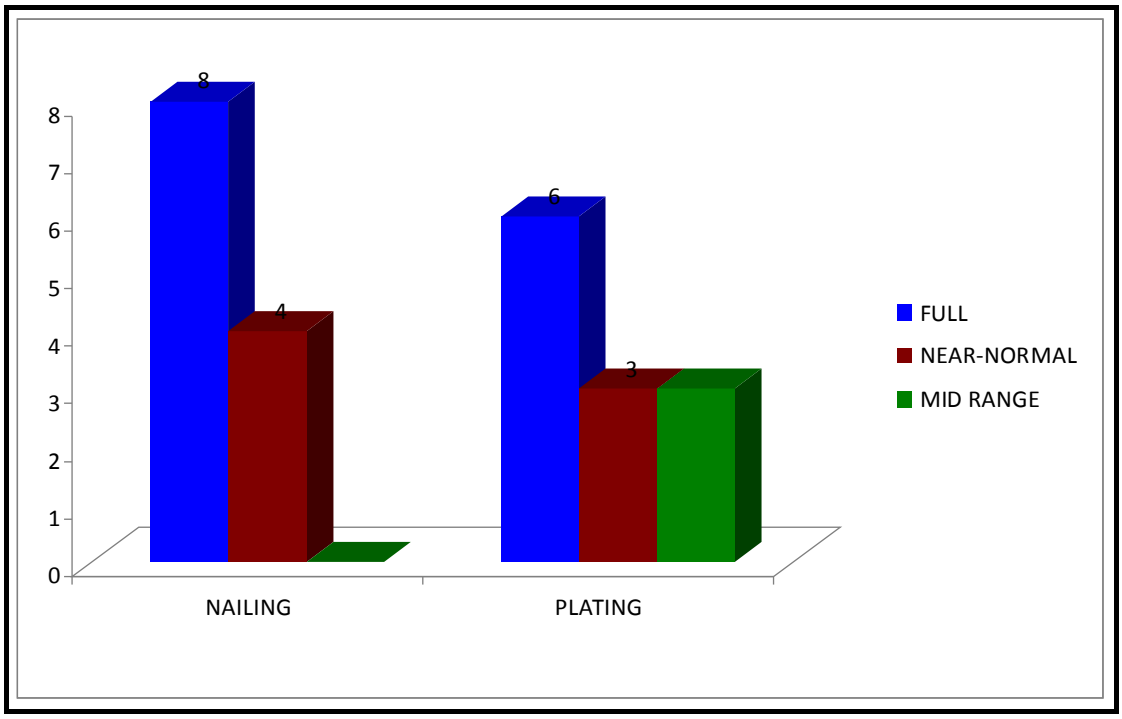


tolerates and it is about 75% .In nail group in 25% the fibula is fixed and delayed weight bearing was recommended after one month.In the plate group both tibia and fibula were fixed with open method and the delayed bearing weight was recommended after one month,the p valve is 0.0% it is highly significant

Table-7: Rom Ankle

Rom Ankle	Nailing		Plating	
	No of Patients (N)	Percentage (%)	No of Patients (N)	Percentage (%)
Full	8	66.66	6	50
Near-Normal	4	33.33	3	25
Mid-Range	0	0	3	25
Total	12	100	12	100

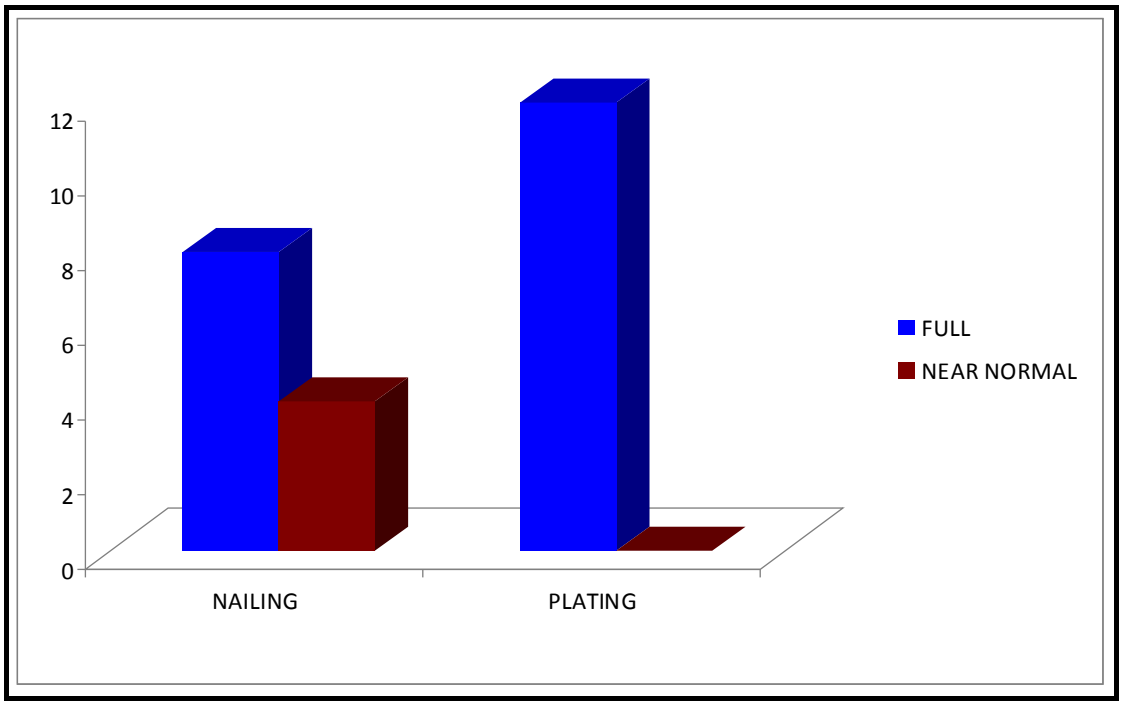
Rom Ankle



The range of movements for the ankle joints for nailing ranges from full to near normal and for the plating group ranges from full to mid range.Among 12 patients 8 patients had full range of movements 4 patients had near normal.In plating group 6 patients had full range of movements 3 patients had near normal and 3 patients had mid range of movements.About 50% of plate group had near normal to mid range of movements.hence the range of movements of the ankle joint in the nailing group is better than plate group.

Table-8: ROM Knee

Rom Knee	Nailing		Plating	
	No of Patients (N)	Percentage (%)	No of Patients (N)	Percentage (%)
Full	8	66.66	12	100
Near Normal	4	33.33	0	0
Total	12	100	12	100

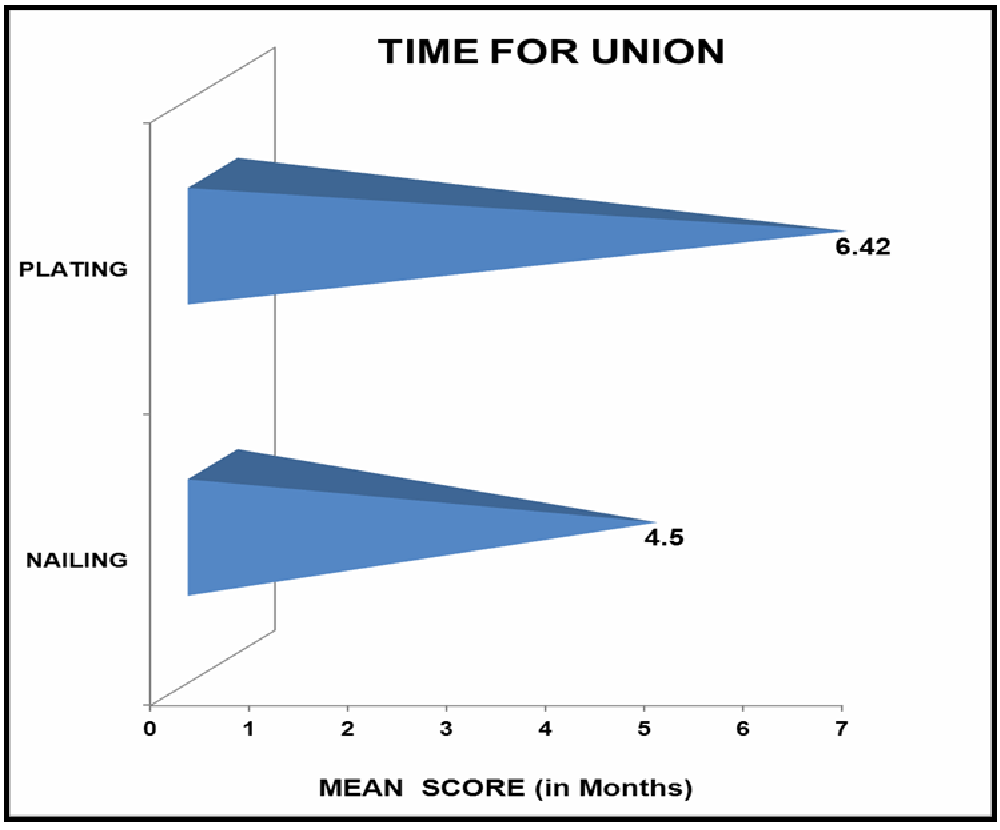


The range of movements for the knee joint for both the nailing and plate group is full to near normal. In the nailing group the 8 patients had full range of movements and 4 patients had near nomal range of movements. In the plate group 12 patients had full range of movements.

Table-6: Time For Union (In Months)

Time for union (in months)	Nailing		Plating	
	Mean	sd	Mean	sd
	4.50	0.52	6.42	2.56
t-value	2.53			
p-value	0.02			
Significant	Significant			

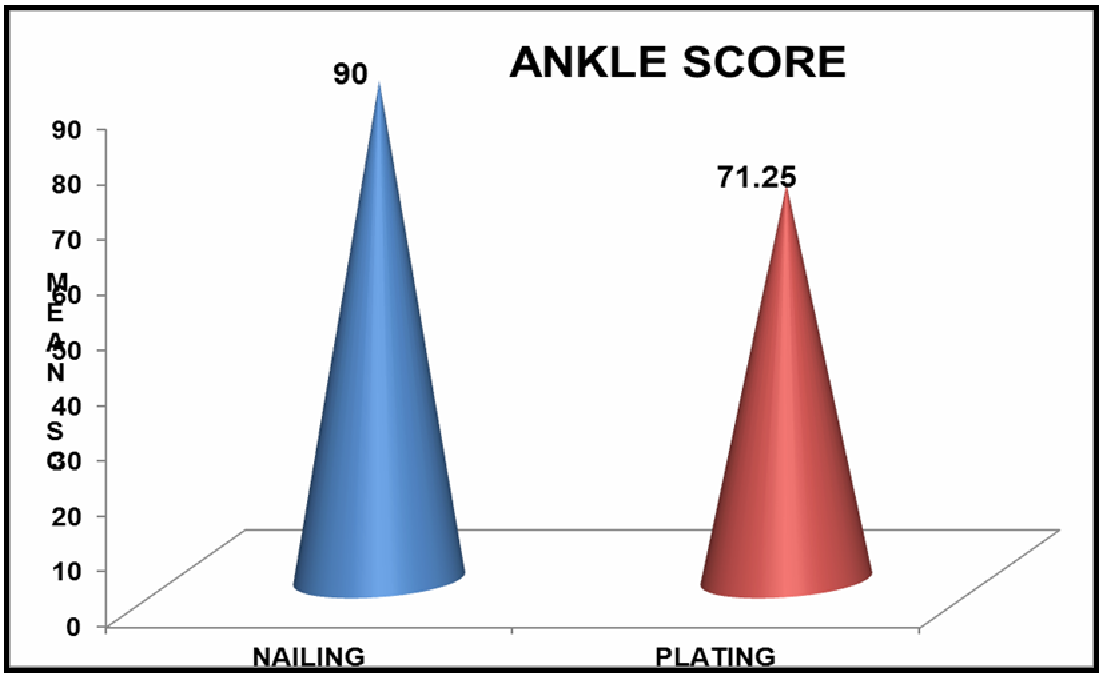
Time for union for the nail group and plate group was 4 to 6 months. In the nail group the average time for union was 4months and the plate group the average time for union was 5 months. The t-valve is 2.53 and the p-valve is 0.02 and it is significant.



The time for union for nail group is shorter than the plate group . Hence the nail group is better than the plate group.

Table-9: Ankle Score

Ankle Score	Nailing		Plating	
	Mean	**Sd**	**Mean**	**Sd**
	90.00	3.69	71.25	6.44
t-value	8.75			
p-value	0.000			
Significant	Significant			

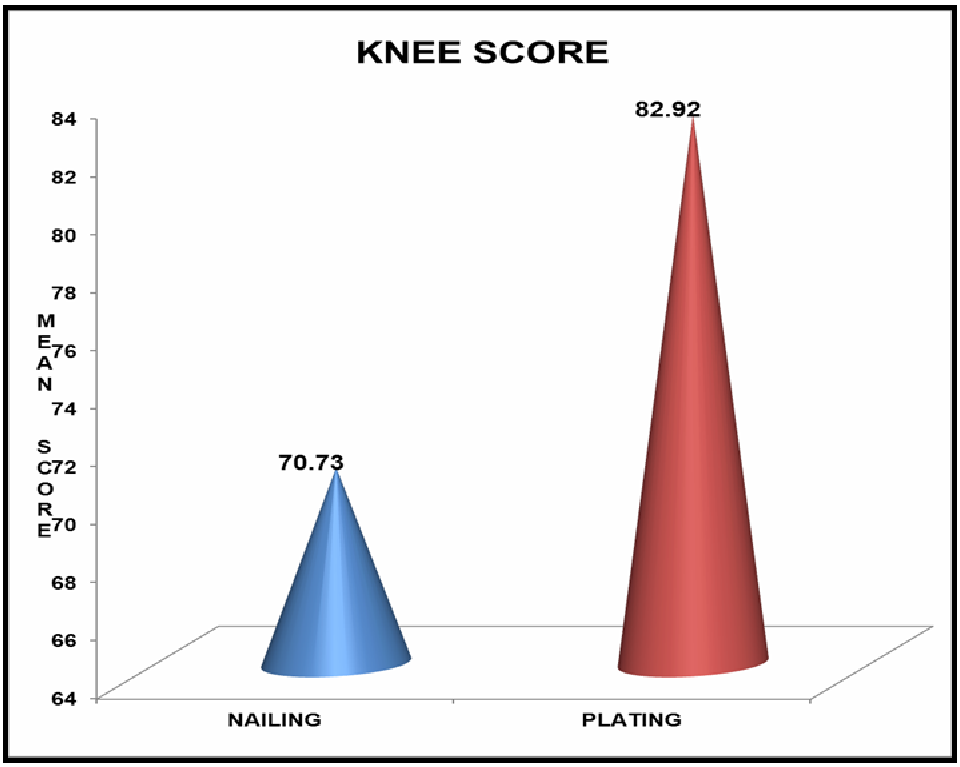


The ankle score for both the nail and plate group range from excellent to fair group. In the nail group the ankle score was good to excellent. In the plate group the the ankle score was fair to good. The t-valve is 8.75 and the p-valve is 0.0 and it is significant.

Table-10: Knee Score

	Nailing		Plating	
	Mean	**sd**	**Mean**	**sd**
	70.73	6.75	82.92	5.50
t-value	4.76			
p-value	0.000			
Significant	Significant			

The knee score for the nail and the plate group range from 60 to 90 out of 100. The nail group range from 60 to 80 and the plate group range from 70 to 90. The mean for nail group was70.73and the mean for plate group was 82.92. the t-valve is 4.76 and the p-valve is 0.0 and it is significant for plate group**.**



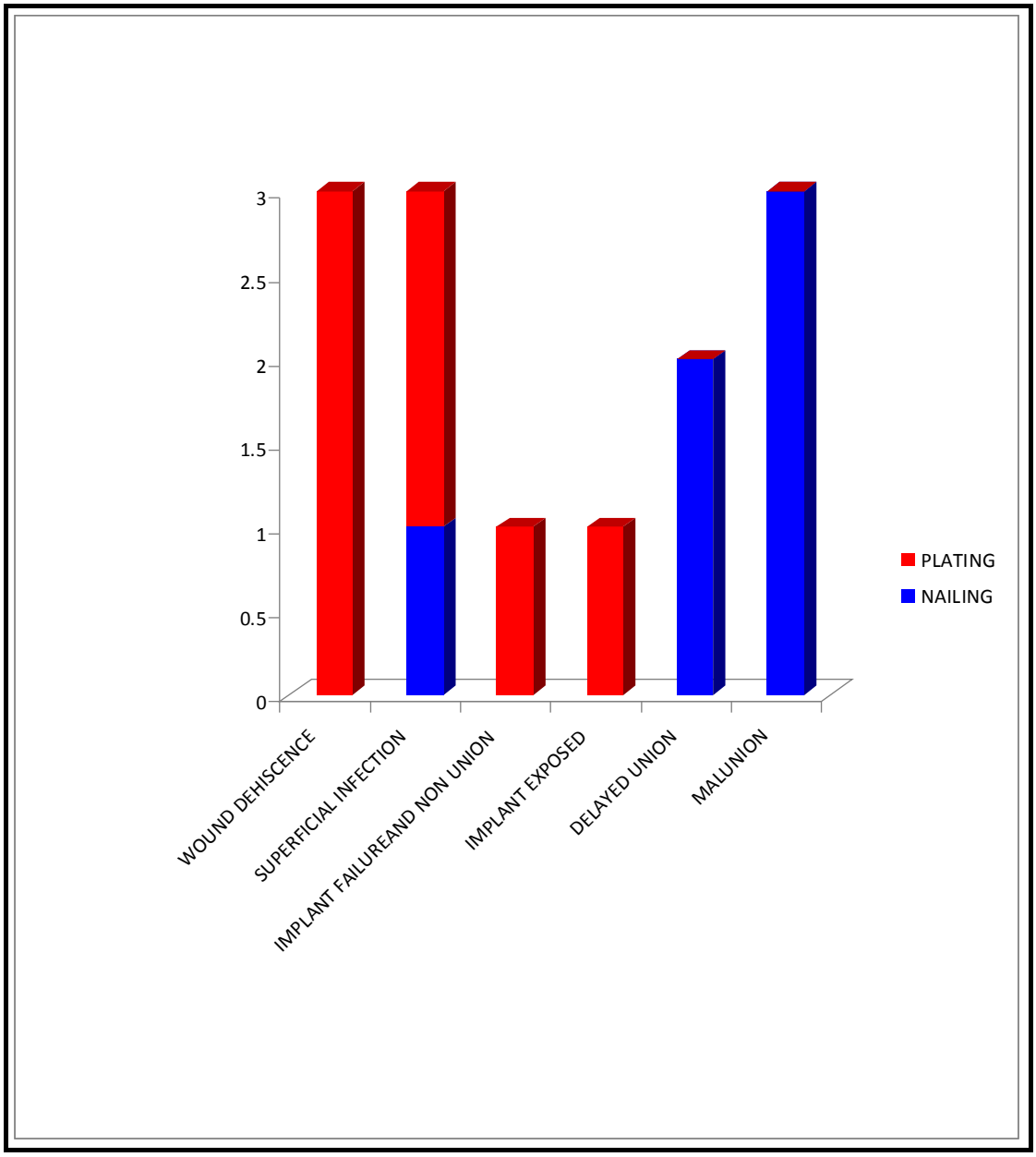
The knee score the plate group was better than the nail group.

Table -11: Complications

Complications	Nailing		Plating	
	No of Patients (N)	**Percentage (%)**	**No of Patients (N)**	**Percentage (%)**
Delayed union	2	16.66	0	0
Implant failure & non union	0	0	1	8.33
Plate exposed	0	0	1	8.33
Superficial infection	1	8.33	2	16.66
Wound dehiscence	0	0	3	25
Malunion	3	25	0	0
Total	6	50	7	58
p-value	0.98			
Significant	Not Significant			

The complication rate in the plate group is high compared to the nail group.the complication noted in the nail group was delayed union and the superficial infection and it was about 25% . The complication noted in the plate group was the wound dehiscence, superficial infection,implant exposed , implant failure and non union.The complication rate was more than 50%.

COMPLICATIONS



The complication rate was less in the nail group while compared to plate group. Hence the nail group was better than plate group.

LYSHOLM KNEE SCORING SCALE

1) LIMP

- I have a constant and severe limp when I walk. (0)
- I have a periodical or slight limp when I walk. (3)
- when I walk I have no limp. (5)

2) Using Crutches or Cane

- Impossible to put weight on my hurt leg(0)
- I use a crutches or cane with some weight-bearing. (2)
- I do not use crutches or cane. (5)

3) Locking Sensation in the Knee

- At this moment my knee feels locked. (0)
- Frequently my knee locks. (2)
- Occasionally my knee locks. (6)
- I have no locking sensation in my knee but there is catching sensation . (10)
- I have no catching and no locking sensations in my knee. (15)

4) Pain

- In my knee i have constant pain. (0)
- During or after walking less than 1 mile i have severe pain in my knee. (5)
- I have severe pain in my knee during vigorous activities. (15)
- During or after walking more than 1 mile i have severe pain in my knee. (10)
- In my knee i have no pain. (25)

5) Giving Way Sensation From the Knee

- My knee gives way every step I take. (0)
- My knee often gives way during daily activities. (5)
- My knee occasionally gives way during daily activities. (10)
- My knee gives way frequently during athletics or other vigorous activities in turn I am unable to participate in these activities. (15)

- ❖ My knee rarely gives way,when doing vigorous activities or during atheletes. (20).
- ❖ My knee never gives way. (25)

6). Swelling

- ❖ I have in my knee swelling constantly. (0)
- ❖ After ordinary activities I have swelling in my knee . (2)
- ❖ Only after vigorous activities I have swelling in my knee . (6)
- ❖ In my knee I have no swelling. (10)

7) Squatting

- ❖ Squatting is impossible because of my knee problem. (0)
- ❖ I can not squat beyond a 90 degree bend in my knee. (2)
- ❖ I have slight problems squatting. (4)
- ❖ I have no problems squatting. (5)

8) Climbing Stairs

- ❖ Climbing stairs is impossible for me. (0)
- ❖ Other vigorous activities,

- ❖ I can climb stairs only one at a time. (2)
- ❖ I have slight problems climbing stairs. (6)
- ❖ I have no problems climbing stairs. (10)

TOTAL_____/100

The LYSHOLM KNEE SCORING SCALE is based on the the pain and it varies from no pain to worse pain. The greater score the the patient has no pain the lesser score the worse pain

KAIKKONEN ANKLE SCORE

Injured ankle subjective assessment:

Severe Symtoms	0
Moderate Symptoms	5
Mild Symptoms	10
No symptoms of any kind	15

Walk normally

No	0
Yes	10

Run normally

No	0
Yes	10

Climbimg downstairs

Over 20 seconds	0
18-20 seconds	5
Under 18 seconds	10

With injured leg heel rising

Under 30 times	0
30-39 times	5
Over 40 times	10

With injured leg rising of toes

Under 30 times	0
30-39 times	5
Over 40 times	10

With injured leg single limb stance

Over 55 seconds	10
50-55 seconds	5
Under 50 seconds	0

The ankle joint laxity

Stable (<5mm)	10
Moderate instability	5
Unstable	0

Dorsiflexion Range of motion

>10 degrees	10
5—9 degrees	5
<5 degrees	0

Outcomes

Poor <50

Fair 55-65

Good 70-80

Excellent >85

DISCUSSION

Distal tibia fractures result from low energy torsional or high energy axial-loading mechanisms. High energy fractures are commonly associated with severe soft tissue injury, comminution of metaphyseal and articular fracture fragments of tibial plafond and comminuted distal fibula fractures. Tibial pilon fractures account for <10% of lower extremity fractures and occur in adults owing to fall from height or from road traffic accidents. The optimal treatment for these fractures remains controversial. This is due to the associated significant soft tissue injury and precarious vascular supply of distal tibia.Treatment of distal tibia fractures can be challenging because of its subcutaneous location, poor vascularity and limited soft tissue.

The main factor in treating these injuries is to estimate the degree of associated soft tissue injury. Since open and closed fractures were included in our study, we used Tscherne soft tissue injury classification to assess and grade the severity of soft tissue injury. Definitive fixation is advaisable and proceeded only when the soft tissue injury heals. This is indicated by the skin wrinkle sign, once limb edema subsides. In our study, internal fixation was carried out at an average of 2 to 3 weeks once wrinkle sign developed.

Minimally invasive plating techniques (MIPPO) reduce the iatrogenic soft tissue injury and damage to bone vascularity, and also preserve the osteogenic fracture hematoma. But even MIPPO techniques should be performed after soft tissues heal. And with a delay of three weeks, MIPPO is not possible in some cases. This is why in our study too, MIPPO could not be carried out even in some AO type A fractures.

The key principles in the management of these fractures are – 1)Restoration of the length and limb axis by open reduction and internal fixation of fibula fracture;

2) the anatomical reconstruction of the articular surface of tibial plafond;

3) the filling of the defect resulting from impaction and the support of the lateral side of tibia, by lateral plating to prevent the valgus deformity[2].

In our study the distal tibial fractures are treated with the multi directional locked nailing and anterolateral plating.The fracture fixation was delayed for about two to three weeks to prevent soft tissue injury complication.In the multidirectional locked nailing the length and the diameter varies according to the

patient and for plating universally the 3.5 mm locking compression plate used for tibia fixation and one third tubular plate for fibular fracture fixation.

Among 24 patients the 12 patients are treated with multi directional nailing and 12 patients are treated with anterolateral plating. Among 12 patients in nailing 9 patients are operated in the closed method and 3 patients are treated with open method.

In AO type classification 43 A1,43 A2 ,43 A3 types were used in our study for internal fixation.24 patients were included in our study. In our study the peak incidence age group lies between 35 to 55 years.

Strong fixation and good reduction can be achieved by plating,but this technique tends to increase the risk of infection,delayed union ,non union by disrupting the periosteal blood supply.It was concluded that the infection rate was 25%including wound dehiscence in 2 cases and deep infection leading to plate exposed in 1 case out of 12 cases of plating with average follow up of 10 months.

There were **one superficial** infections (8.3%) noted in the nailing and two superficial infection and another deep infection

(25%) in plating.The infection rates are comparable to the study done by Sean E Nork et al[56] (7%).

In the study conducted by Tyllianakis M et al[4] and Sean E Nor[67] et al , the average time for union was about 4-5 months.In our study the average time for union for nailing was 4.5 months and for plating was 6.4 months.

There was 2 cases of delayed union in the nail group at 4 months.after dynamaisation at 4 months they united at 6 months uneventfully. This is comparable to studies conducted by Fan CY[29] et al 57 and Aso Mohammad et al[57]

No incidence of non union noted in the nailing and in the platins there was two cases of non union with implant failure.

The ankle score in our study in nailing was excellentand the ankle score for plating was good to excellent .This shows that the ankle function was restored well in all the patients. The results are comparable with the results of ankle function in the study conducted by Shon OJ et al[58] (Average IOWA ANKLE rating score was excellent)

The knee function was restored well in most of the patients These results are comparable to the results of knee function in the

study conducted by Paraschous S et al[59] (Knee score- 81 Good)Hence the overall functional outcome of patients treated in our study was good.

There were three cases (25%) of malunion whose ankle and knee scores were lesser compared to the other patients included in the study. In the study conducted by Boos N et al[60] in 51 cases of distal tibial fracture with interlocking nail, there was incidence of 16% malunion. Comparatively, the rate of malunion was little higher in our study.

Ahmed et al reported a success rate of 76.4% by using plating in 17 patients.Because of restrictions of intramedullary nailing technology plating was preferred in the past. More and more often the intramedullary nail being performed now-a-days because this technique protects the blood supply, lower the incidence of infection,reduce the soft tissue destruction and lower the incidence of delayed healing.

Malalignment was the major problem in nailing when compared to the plating,reduction and maintaining the reduction without malalignment were difficult in nailing cases.In 3 out of 12

cases the more than 5 degree axial angulation noted ,which represents 25% of axial angulation.

The time duration of the operating time in the nail group is longer than the plate in our study.Inspite of longer operating time many authors recommends the intramedullary nail because the risk of infection was increased in plate fixation.

There are different blood supplies outside and inside the tibia.The anterior and posterior tibial vessels gives the the periosteal blood supply nourishing the one third of lateral side of cortical bone.The nutrient vessels and the metaphyseal vessels supplies the remaining two third of the bone cortex and the the periosteum.The destruction of the endosteal vessel occurs while reaming but the vessels grows in between the nail and the bone widening the haversian canal.Simultaneously the cortical bone receives the periosteal blood supply.Hence comparatively the blood supply at the fracture site preserved in the nailing technique.

In our study the fracture union time is shorter in the nail group compared to plate group as indicated by significant p value.Malunion rate was 25% in the nail group and 16.6% in the plate group showing significant statistics value.Malunion is defined

as axial angulation more than 5 degree, shortening of 1 cm or more ,angular rotation of more than 10 degree. The shortening and the rotation deformity was not significant statistically.There were 2 cases of delayed union in the nail group and no incidence of non union noted in the nail group. But one case of non union with implant faiure case noted in the plate group .Two cases of the wound dehiscence and one case of deep infection rate noted leading to implant exposed in the plate group ,one case of extensor tendon exposed noted in the the plate group.

According to the results in our study, the fracture union rate is shorter in the nail group,the malunion rate is higher in the nail group,due to shorter time of union compared to the plate group the functional exercise started earlier.the infection rate is higher in the plate group leads to complication like wound dehiscence,tendon exposed, implant exposed and implant failure and non union.therefore the multidirectional intramedullary nail is superior than the plate.

CONCLUSIONS

Distal tibial fractures can be effectively treated by interlocking intra medullary nails with multi directional locking options with excellent results.

The operative technique was simple and short. Very minimal complications were encountered in our study.

No cases of non-union were found. The post operative infection rate was low.

Wound healing problems were not encountered. As nails are weight sharing devices, immediate weight bearing could be initiated.

The post operative outcome as measured by ankle and knee scores and range of movements were good to excellent. Fibular fixation can be combined with nailing in indicated cases for excellent results.

Hence, interlocking intra medullary nailing combined with multi directional locking can be considered a very effective modality of treatment of indicated distal tibial fractures.

RECOMMENDED STRATEGIES FOR FURTHER RESEARCH

There is limited information on which to make evidence-based treatment recommendations for treatment of distal tibia fractures. Current results are influenced by selection bias because more severe fractures are often treated differently than less severe ones. Future studies could benefit from any of the following design improvements or additions:

- Comparisons of IM nailing and plate fixation on patients with same fracture type and similar prognostic factors.
- Use of validated outcome measures, including patient reported outcomes that measure function and quality of life.
- Use of clinical outcome assessors who are blinded to treatment.
- Use of studies with sufficient statistical power that are designed to limit bias.
- Well-designed studies of long-term outcomes and impact of rehabilitation programs.

- Comparisons of surgical outcomes to conservative treatment outcomes among patients with same fracture type and prognostic factors.
- Well-designed comparative studies (RCTs or prospective cohort studies) to evaluate factors which may influence outcomes.

BIBILIOGRAPHY

1) **Bourne RB, Rorabeck CH, Macnab J** (1983) Intra-articular fractures of the distal tibia: the pilon fracture. J Trauma 23:591–596

2) **Ovadia DN, Beals RK** (1986) Fractures of the tibial plafond. J Bone Joint Surg Am 68:543–551

3) **Marsh JL, Saltzman CL** (2001) Ankle fractures. In: Bucholz RW, Heckman JD (eds) Rockwood and Green‘s fractures in adults. Lippincott Williams & Wilkins, Philadelphia, pp 2001–2090

4) **Tyllianakis M, Megas P, Giannikas D, Lambiris E** (2000) Interlocking intramedullary nailing in distal tibial fractures. Orthopedics 23:805–808

5) **Singer BR, McLauchlan GJ, Robinson CM, et al** (1998) Epidemiology of fractures in 15,000 adults: the influence of age and gender. *J Bone Joint Surg Br;* 80:243-8.

6) Michael.W.Chapman ; Chapman’s Orthopaedic Surgery

7) S.Terry Canale, James.H.Beaty ; Campbells operative orthopaedics 11th edition.

8) **Ruedi TP, Allgower M** (1969) Fractures of the lower end of the tibia into the ankle-joint. Injury 5:130

9) **Robinson CM, McLauchlan GJ, McLean IP, Court-Brown CM** (1995) Distal metaphyseal fractures of the tibia with minimal involvement of the ankle. Classification and treatment by locked intramedullary nailing. J Bone Joint Surg Br 77:781–787

10) **Mosheiff R, Safran O, Segal D, Liebergall M** (1999) Theunreamedtibial nail in the treatment of distal metaphyseal fractures. Injury 30:83–90

11) Kulkarni Text book of Orthopaedics – 2nd edition

12) Mast J. A test of surgical judgement. In; Major Fractures of the pilon, the Talus, and the Calcaneus, ed by Tscherne H, Schatzker J. Berlin, Springer-Verlag, 1993,7-27.

13) Martin JS, Marsh JL, Bonar SK, et al. Assessment of the AO/ASIF fracture classification for the distal tibia. J Orthop Trauma. 1997;11: 477-483

14) David J.Hak ; Anterolateral approach for Tibial Pilon Fractures; Trauma Update; February 2012 | Volume 35 | Number 2.

15) Reudi T, Matter P, Allgower M et al. Intra-articular fractures of the distal tibial end. Helv Chir Acta. 1968;35:556-582.

16) Reudi TP, Allgower M et al. The operative treatment of intra-articular fractures of the lower end of the tibia. Clin Orthop Relat Ras 1979(138):105-110.

17) Pugh KJ, Wolinsky PR et al. Tibial Pilon fractures: a comparision of treatment methodsJ Trauma 1999;47:937-941

18) Rakesh K, Gupta, Rajesh Kumar Rohbilla et al. Locking plate fixation in distal metaphyseal tibial fractures: series of 79 patients. Int Orthop 2010 December;34(8):1285-1290.

19) Helfet DL, Koval K et al. Intraarticular pilon fractures of the tibia. Clin Orthop Relat Res 1994(298):221-228.

20) Howard JJ, Barie et al. A prospective study of evaluating incision placement and wound healing for tibial plafond fratures. J Orthop trauma. 2008;5:250-255.

21) Hasenboehler E, Rikli D et al. Locking compression plate with minimally invasive plate osteosynthesis in distal tibial fractures: a retrospective study of 32 patients. Injury 2007, Mar;38(3):365-370.

22) Wyrsch B, Mcferran MA, et al. Operative treatment of fractures of the tibial plafond. A randomized prosepective study. J Bone Joint Surg Am.1996;78:1646-1657.

23) Tornetta P, 3rd, Weiner L, Bergman M, et al (1993) Pilon fractures:treatment with combined internal and external fixation. *J Orthop Trauma;* 7:489-96.

24) **Khoury A, Liebergall M, London E, et al** (2002) Percutaneous plating of distal tibial fractures. *Foot Ankle Int;* 23:818-24.

25) **de la Caffiniere JY, Benzimra R, Chanzy N** (1999) [Treatment of distal metaphyseal fractures of the tibia with the interlocking flexible osteosynthesis system].*Rev ChirOrthopReparatriceAppar Mot;* 85:42-50.

26) **Helfet DL, Shonnard PY, Levine D, et al** (1997) Minimally invasive plate osteosynthesis of distal fractures of the tibia. *Injury;* 28: A42-7; discussion A47-8.

27) **Leung F, Kwok HY, Pun TS, et al** (2004) Limited open reduction and Ilizarov external fixation in the treatment of distal tibial fractures. *Injury;* 35:278-83.

28) **Anglen JO** (1999) Early outcome of hybrid external fixation for fracture of the distal tibia. *J Orthop Trauma;* 13:92-7.

29) **Fan CY, Chiang CC, Chuang TY, et al** (2005) Interlocking nails for displaced metaphyseal fractures of the distal tibia. *Injury;* 36:669-74.

30) **Rzesacz EH, Konneker W, Reilmann H, et al** (1998) [Combination of intramedullary nail and covered screw osteosynthesis for managing distal tibial fracture with ankle joint involvement]. *Unfallchirurg;* 101:907-13.

31) **Blauth M, Bastian L, Krettek C, et al** (2001) Surgical options for the treatment of severe tibialpilon fractures: a study of three techniques. *J Orthop Trauma;* 15:153-60.

32) **Mitkovic MB, Bumbasirevic MZ, Lesic A, et al** (2002) Dynamic external fixation of comminuted intra-articular fractures of the distal tibia (type C pilon fractures). *ActaOrthopBelg;* 68:508-14.

33) **Sirkin M, Sanders R, DiPasquale T, et al** (2004) A staged protocol for soft tissue management in the treatment of complex pilon fractures. *J Orthop Trauma;* 18:S32-8.

34) **Maffulli N, Toms A, McMurtie A, et al** (2004) Percutaneous plating of distal tibial fractures. *International Orthopaedics;* 28:159-162.

35) **Rzesacz EH, Konneker W, Reilmann H, et al** (1998) [Combination of intramedullary nail and covered screw osteosynthesis for managing distal tibial fracture with ankle joint involvement]. *Unfallchirurg;* 101:907-13.

36) **Mitkovic MB, Bumbasirevic MZ, Lesic A, et al** (2002) Dynamic external fixation of comminuted intra-articular fractures of the distal tibia (type C pilon fractures). *ActaOrthopBelg;* 68:508-14. 87

37) **Williams TM, Marsh JL, Nepola JV et al** (1998) External fixation of tibial plafond fractures: is routine plating of the fibula necessary? J Orthop Trauma 12:16–20

38) **Dogra AS, Ruiz AL, Thompson NS, Nolan PC** (2000) Diametaphyseal distal tibial fractures – treatment with a shortened intramedullary nail: a review of 15 cases. Injury 31:799–804

39) **Nork SE, Schwartz AK, Agel J et al** (2005) Intramedullary nailing of distal metaphysealtibial fractures. J Bone Joint Surg Am 87:1213–1221

40) **EgolKA,Weisz R, Hiebert R et al** (2006) Does fibular plating improve alignment after intramedullary nailing of distal metaphyseal tibia fractures? J Orthop Trauma 20:94–103

41) **Kumar A, Charlebois SJ, Cain EL et al** (2003) Effect of fibular plate fixation on rotational stability of simulated distal tibial fractures treated with intramedullary nailing. J Bone Joint Surg Am 85:604–608

42) **Im GI, Tae SK** (2005) Distalmetaphyseal fractures of tibia: a prospective randomized trial of closed reduction and intramedullary nail versus open reduction and plate and screws fixation. J Trauma 59:1219–1223; discussion 1223

43) **Whorton AM, Henley MB** (1998) The role of fixation of the fibula in open fractures of the tibial shaft with fractures of the ipsilateral fibula: indications and outcomes. Orthopedics 21:1101–1105

44) **Nork SE, Schwartz AK, Agel J, Holt SK, Schrick JL, Winquist RA** (2005) Intra medullary nailing of distal metaphyseal fractures, J Bone Joint Surg Am. 2005 Jun; 87(6):1213-21

45) **Bucholz RW, Heckman JD, Court-Brown C, Tornetta P**, eds. *Rockwood and Green's Fractures in Adults*. 6th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2006.

46) **Trafton PG. Closed unstable fractures of the tibia**. *ClinOrthopRelat Res*. 1998; (230):58–67.

47) **Helfet DL, Shonnard PY, Levine D, Borrelli J Jr.** Minimally invasive plate osteosynthesis of distal fractures of the tibia. *Injury*. 1997; 28(suppl1):A42-47.

48) Sherif Mohamed Abdelgaid, Mohamed Abdulghany Ahmed and Emad Gaber Abdel-Mageed ; Minimally Invasive Treatment Protocol for Closed Pilon Fractures; Clin Res Foot Ankle 2013, 1:2

49) **Gray's Anatomy, 40th Edition, The anatomical basis of clinical practice 2008.**

50) Egol KA, Kubiak EN, Fulkerson E, et al. Biomechanics of locked plate and screws. J. Orthop Trauma 2004;18(8):483-93.

51) Ruedi T. Fractures of the lower end of the tibia into the ankle joint: result 9 years after open reduction and internal fixation. Injury 1973;5:130-134

52) Etter C. Operative long term result of tibial pilon fractures treated with open reduction and internal fixation Orthop Trauma 1991;189:1191-1197.

53) Kellam JF, Waddell JP. Fractures of the distal tibia metaphysis with intra-articular extension: the distal tibial explosion fractures. J Trauma 1979;19:593-609

54) Surgical exposures in Orthopaedics – Stanley Hoppenfield – fourth edition

55) Rockwood and greens – Fractures in adult – seven edition.

56) **E.. Nork, Alexandra K. Schwartz, Julie Agel**, JBJS, Vol 87, Issue 6

57) **Aso Mohammed, 1 Ramaswamy Saravanan,2 Jason Zammit,3 and Richard King4**, IntOrthop. 2008 August; 32(4): 547–549.

58) **Shon OJ, Chung SM**, *J Korean Fract Soc*. 2007 Jan;20(1):13-18. Korean

59) **Paraschou S, Bekir H, Anastasopoulos H, Papapanos A, Alexopoulos J, Karanikolas A, Roussis N**, ActaOrthopTraumatolTurc. 2009;43(6):472

60) **Boos N, Bugyi I,** Unfallchirurg. 1989 Sep;92(9):453-8.

PROFORMA

Case No:…… Unit:……

Name:…… Age/Sex:…..… /……

I.P No: …… Occupation:…… …..

Address:……

……

……

……..Phone:……

Date of injury : ……./……./……

Date of admission : ……./……./……

Date of definitive surgery : ……./……./……

Date of discharge : ……./……./……

Mechanism of injury:

Road traffic accident
Fall FROM HEIGHT
SELF FALL

Others……

Severity of injury:

High velocity
Moderate velocity
Trivial

General condition:

Conscious
Drowsy
Unconscious

Haemodynamic status:

Stable	(Systolic BP>110 mmHg, PR<90/min)
Moderately stable	(Systolic BP 70 to 90 mmHg, PR 90 to 110/min)
Unstable	(Systolic BP<70 mmHg, PR>110/min)

Side involved: (Right/Left)

Type of injury:

(a) Closed
(b) Open
Grade I

X ray findings:

Type of the fracture:

Type A: Extra-articular

A1: simple # of metaphysic
A2: metaphyseal wedge #
A3: complex metaphyseal

Associated other long bone injuries: (Yes/No)

_____

_____

Associated head injury: (Yes/No)

Treatment history:

Treatment elsewhere if any:

_____

_____

_____

_____

_____

Treatment in our institution:

<u>Initial management:</u>

Date **: _____/_____/_____**

Time interval between injury and initial management:

_____

Procedure done :

_____

_____

_____

_____

_____

_____

Additional stabilization:

_____

_____

_____

_____

Bone grafting : (Yes / No)

Blood transfusion : (Yes / No)

Intraoperative events and difficulties :

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Stability of fixation :

_____

Immediate post operative events

Complications :

_____

_____

_____

_____

_____

Post operative immobilization :

_____

Post operative alignment :

_____

Limb length discrepancy :

_____

Other injuries if any and their management :

_____

_____

_____

_____

_____

FOLLOWUP

Radiological picture

Sign of callus : _____

Bony union : _____

Consolidation : _____

Remodelling : _____

1st Follow up	**Date :**	**Complaints**	
		Wound	
		x-ray	
		Ankle score	
		Asst. Sign	

Follow up	**Date :**	**Complaints**	
		Wound	
		x-ray	
		Ankle score	
		Asst. Sign	

Follow up	**Date :**	**Complaints**	
		Wound	
		x-ray	
		Anklescore	
		Asst. Sign	

Follow up	**Date :**	**Complaints**	
		Wound	
		x-ray	
		Ankle score	
		Asst. Sign	

PATIENT CONSENT FORM

Study Detail : **COMPARISON OF MULTIDIRECTIONAL INTRAMEDULLARY NAILING VS PLATING FOR DISTAL TIBIAL FRACTURES**

Study Centre : RajivGandhiGovernment GeneralHospital, Chennai.

Patient's Name :

Patient's Age :

Identification Number :

Patient may check (√) these boxes

a) I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ❑

b) I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ❑

c) I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ❑

d) I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well being or any unexpected or unusual symptoms. ❑

e) I hereby consent to participate in this study. ❑

f) I hereby give permission to undergo detailed clinical examination, Radiographs ,blood investigations and surgical procedure as required. ❑

Signature/thumb impression Signature of Investigator

Patient's Name and Address: Study Investigator's Name:**Dr.A. ANAND KUMAR**

PATIENT INFORMATION SHEET

TITLE OF THE STUDY : **Comparison Of OF MULTIDIRECTIONAL INTRAMEDULLARY NAILING VS PLATING For Distal Tibial Fractures**

We are conducting a study on **"COMPARISON OF PLATING VS INTERLOCKING NAILING FOR DISTAL TIBIAL FRACTURES"** among patients admitted in the Institute of Orthopaedics & Traumatology, Rajiv Gandhi Government General Hospital, Chennai.

The purpose of this study is to evaluate and analyse the clinical outcome of internal fixation of fractures with infective foci elsewhere.

We are selecting certain cases based clinical pattern of fracture with infective foci elsewhere and if you are found eligible, we perform surgical procedure for the fractured limb by any internal fixation technique or if you are all already operated for the fracture by internal fixation with infective foci elsewhere, we will evaluate the outcome of surgery, which in any way do not affect your final report or management.

The privacy of the patients in the research will be maintained throughout the study. In the event of any publication o r presentation resulting from the research, no personally identifiable information will be shared.

Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.

The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of Investigator

Signature of Participant

Date :

ஆய்வு தகவல் தாள்

ஆராய்ச்சியாளர் பெயர் :

தலைப்பு : டிபியா எலும்பு முறிவுக்கு தட்டு வைத்து அறுவை சிகிச்சை மேற்கொண்டு , செயல்பாட்டு விளைவினை அளவிடும் மருத்துவ ஆய்வு .

சென்னை அரசு பொது மருத்துவமனையில் டிபியா எலும்பு முறிவுக்கு சிகிச்சைக்காக சேர்க்கப்படும் நோயாளிகளில் மேர்க்கொள்ளப்படும் மருத்துவ ஆய்வு .

இந்த மருத்துவ ஆய்வின் நோக்கம் டிபியா எலும்பு முறிவுக்கு தட்டு வைத்து அறுவை சிகிச்சை செய்வதன் மூலம் பெறப்படும் செயல்பாட்டு விளைவினை கண்டறிதல் .

ஊடு கதிர் நிழற்படம் வைத்து சில குறிப்பிட்ட வகையான டிபியா எலும்பு முறிவு கொண்ட நோயாளிகள் மட்டும் ஆய்வுக்கு எடுத்து கொள்ளப் படுவார்கள். தேர்ந்தெடுக்கப்பட்ட நோயாளிகள் மயக்க மருந்து நிபுணர் ஒப்புதல் பிறகு தட்டு வைத்து அறுவை சிகிச்சைக்கு மேற்க்கொள்ளப்படுவார்கள்.

அறுவை சிகிச்சைக்கு பின் ஒரு மாத காலம் மாவு கட்டு போடப்படும். அறுவை சிகிச்சைக்கு முன் மற்றும் அறுவை சிகிச்சைக்கு பின் எடுக்கப்படும் ஊடு கதிர் நிழற் படங்கள், ஆராய்ச்சிக்கு பயன்படுத்தப்படும்.

மேலும் அறுவை சிகிச்சைக்குப்பின் 6 , 10 , 12 வார காலங்களில் நோயாளியின் அறுவை சிகிச்சைக் காயம் மற்றும் ஊடு கதிர் நிழற்படம் எடுக்கப்பட்டு எலும்பு சேர்ந்துவிட்டதா என்றும் கால் செயல்பாட்டு அளவும் ஆராயப்படும் .

மேலும் இதற்கு முன்னால் நடந்த ஆய்வில் எந்த பக்க விளைவுகளும் இல்லை என்று உறுதிப் படுத்தியுள்ளது.முடிவுகளை அல்லது கருத்துக்களை வெளியிடும் பொழுது அல்லது ஆய்வின் பொழுது தங்கள் பெயர் , அடையாளங்கள் வெளியிடப்படமாட்டாது என்பதையும் தெரிவித்து கொள்கிறோம்.

பங்குபெறுபவர் பெயர் : ஆய்வாளர் பெயர் :

கையோப்பம் : கையோப்பம் :

இடம் : தேதி :

<u>சுயஒப்புதல் படிவம்</u>

தலைப்பு : டிபியா எலும்பு முறிவுக்கு தட்டு வைத்து அறுவை சிகிச்சை மேற்கொண்டு , செயல்பாட்டு விளைவினை அளவிடும் மருத்துவ ஆய்வு .

பெயர் :
வயது :
பாலினம் :
முகவரி :

தேதி :
வெளி நோயாளி எண் :
ஆராய்ச்சி சேர்க்கை எண் :

நான் _____ இந்த படிவத்தில் உள்ள தகவல்களை படித்தேன். (அல்லது எனக்கு படித்து காட்டப்பட்டது). நான் இந்த மருத்துவ ஆராய்ச்சி பற்றி எந்த தயக்கமும் இன்றி தகவல்களை கேட்டு பெற்று கொண்டேன். நான் 18 வயதை கடந்தவர் என்றும், இந்த ஆராய்ச்சியில் முழு சுதந்திரத்துடன் பங்கேற்க சம்மதம் என்றும் தெரிவித்து கொள்கிறேன்.

1. நான் இந்த ஒப்புதல் படிவத்தை படித்து இதில் உள்ள தகவல்களை நன்கு புரிந்து கொண்டேன்.
2. எனக்கு இந்த ஒப்புதல் ஆவணம் பற்றி நன்றாக விளக்கப்பட்டது.
3. எனக்கு இந்த ஆய்வின் தன்மையை பற்றி விளக்கப்பட்டது.
4. என்னுடைய உரிமை மற்றும் பொறுப்புகள் ஆராய்ச்சியாளர்களால் விளக்கப்பட்டது.

5. நான் இந்த ஆராய்ச்சியில் இருந்து எந்த நேரமும் பின் வாங்கலாம் என்பதையும், அதனால் எந்த பாதிப்பும் ஏற்படாது என்பதையும் புரிந்து கொண்டேன்.

6. இந்த ஆய்வின் மூலம் பெறப்பட்ட என்னுடைய முடிவுகளை வெளியிட விளம்பரதாரர் கட்டுப்பாட்டு அதிகாரிகள், அரசு அதிகாரிகள், நன்னெறி குழு(IEC)க்களுக்கு அனுமதி அளிக்கிறேன்.

7. என் ஆய்வு விவரங்களை பொதுவாக வெளியிடும் பொழுது என்னை பற்றிய அடையாளங்கள் ரகசியமாக வைக்கப்படும் என்பதையும் புரிந்து கொண்டேன்.

8. என் சந்தேகத்திற்கு உரிய பதில்களை திருப்தியுடன் பெற்று கொண்டேன்.

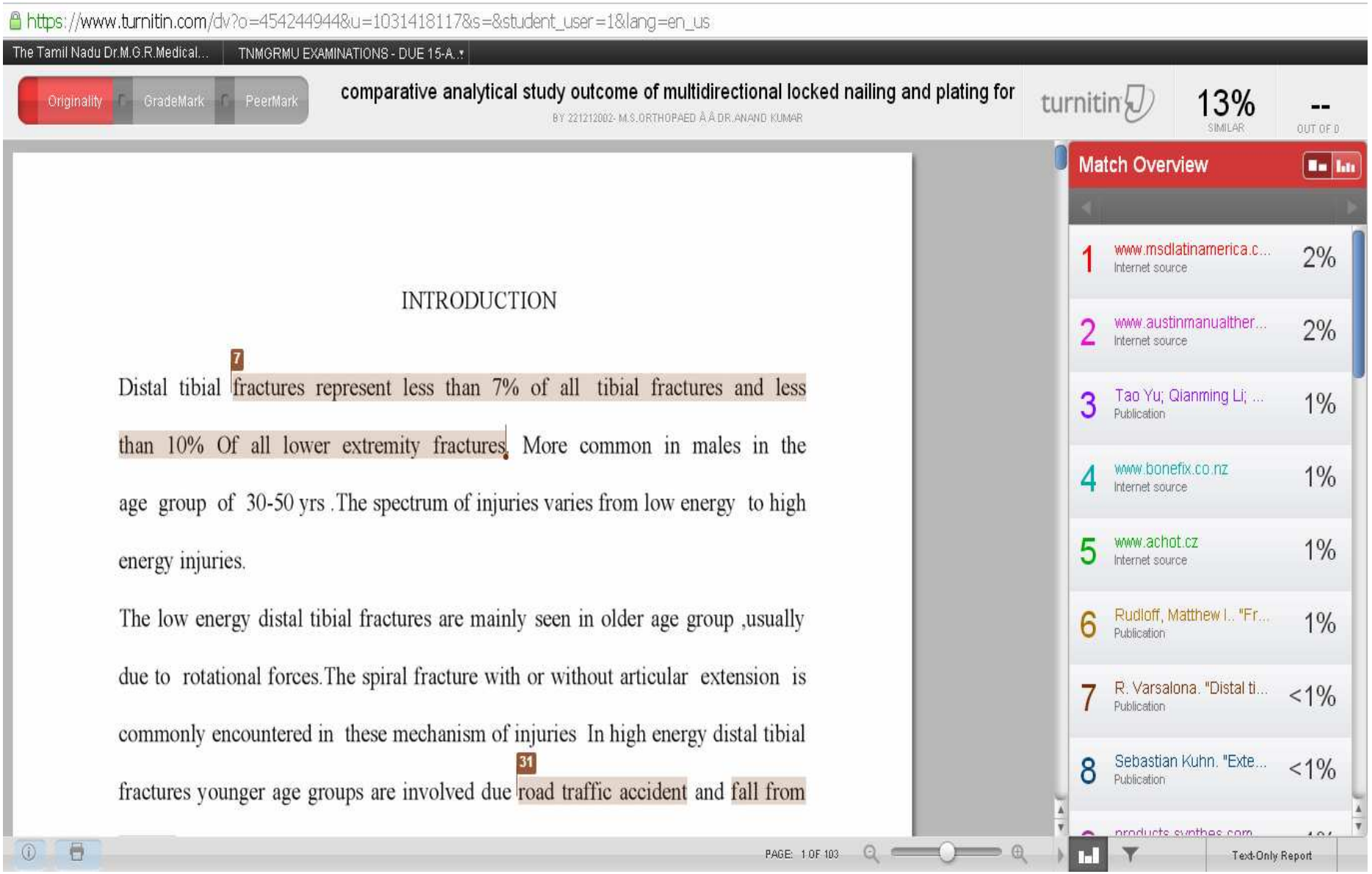
9. நான் இந்த ஆராய்ச்சியில் பங்கு பெற முடிவு செய்திருக்கிறேன்.

எனக்கு இந்த ஆய்வின் போது எழும் சந்தேகங்களை ஆராய்ச்சியாளரிடம் கேட்டு தெரிந்து கொள்ள வேண்டும் என்பதை அறிவேன். நான் இந்த படிவத்தில் கையொப்பம் இடுவதன் மூலம், இந்த ஆய்வை பற்றி எனக்கு நன்றாக விளக்கப்பட்டது எனவும் ஒப்புதல் அளிக்கிறேன். எனக்கு இந்த ஒப்புதல் ஆவணத்தின் நகல் வழங்கப்படும்.

....
.....
நோயாளியின் பெயர் கையொப்பம் / கைரேகை தேதி

....
.....
சாட்சியின் பெயர் கையொப்பம் / கைரேகை தேதி

....
.....
ஆராய்ச்சியாளரின் பெயர் கையொப்பம் தேதி

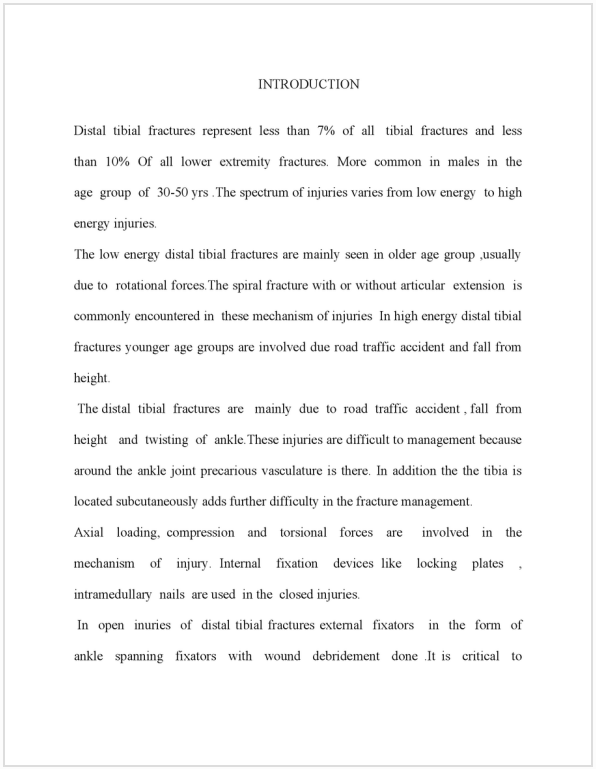

https://www.turnitin.com/dv?o=454244944&u=1031418117&s=&student_user=1&lang=en_us
The Tamil Nadu Dr.M.G.R.Medical...
TNMGRMU EXAMINATIONS - DUE 15-A..
Originality
GradeMark
PeerMark
comparative analytical study outcome of multidirectional locked nailing and plating for
BY 221212002- M.S.ORTHOPAED Â Â DR.ANAND KUMAR
turnitin
13%
SIMILAR
--
OUT OF 0
INTRODUCTION
Distal tibial fractures represent less than 7% of all tibial fractures and less than 10% Of all lower extremity fractures. More common in males in the age group of 30-50 yrs .The spectrum of injuries varies from low energy to high energy injuries.
The low energy distal tibial fractures are mainly seen in older age group ,usually due to rotational forces.The spiral fracture with or without articular extension is commonly encountered in these mechanism of injuries In high energy distal tibial fractures younger age groups are involved due road traffic accident and fall from
PAGE: 1 OF 103
Match Overview
1 www.msdlatinamerica.c... Internet source 2%
2 www.austinmanualther... Internet source 2%
3 Tao Yu; Qianming Li; ... Publication 1%
4 www.bonefix.co.nz Internet source 1%
5 www.achot.cz Internet source 1%
6 Rudloff, Matthew I.. "Fr... Publication 1%
7 R. Varsalona. "Distal ti... Publication <1%
8 Sebastian Kuhn. "Exte... Publication <1%
Text-Only Report

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	221212002- M.s.orthopaed Â Â Dr.A…
Assignment title:	TNMGRMU EXAMINATIONS
Submission title:	comparative analytical study outcome…
File name:	anand_dissertation_final.docx
File size:	17.4M
Page count:	103
Word count:	9,590
Character count:	52,074
Submission date:	23-Sep-2014 02:42AM
Submission ID:	454244944



INTRODUCTION

Distal tibial fractures represent less than 7% of all tibial fractures and less than 10% Of all lower extremity fractures. More common in males in the age group of 30-50 yrs .The spectrum of injuries varies from low energy to high energy injuries.

The low energy distal tibial fractures are mainly seen in older age group ,usually due to rotational forces.The spiral fracture with or without articular extension is commonly encountered in these mechanism of injuries In high energy distal tibial fractures younger age groups are involved due road traffic accident and fall from height.

The distal tibial fractures are mainly due to road traffic accident , fall from height and twisting of ankle.These injuries are difficult to management because around the ankle joint precarious vasculature is there. In addition the the tibia is located subcutaneously adds further difficulty in the fracture management.

Axial loading, compression and torsional forces are involved in the mechanism of injury. Internal fixation devices like locking plates , intramedullary nails are used in the closed injuries.

In open inuries of distal tibial fractures external fixators in the form of ankle spanning fixators with wound debridement done .It is critical to

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI-3

EC Reg No.ECR/270/Inst./TN/2013
Telephone No : 044 25305301
Fax : 044 25363970

CERTIFICATE OF APPROVAL

To
Dr. A. Anandkumar,
PG in Orthopaedics,
Institute of Orthopaedics & Traumatology,
Madras Medical College, Chennai-3.

Dear Dr. A. Anandkumar,

The Institutional Ethics Committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled **"Comparative Analytical Study Outcome of Multidirectional Locked Nailing and Plating for Distal Tibial Fractures"** No.14032014

The following members of Ethics Committee were present in the meeting held on 11.03.2014 conducted at Madras Medical College, Chennai-3.

1.	Dr. C. Rajendran, M.D.	-- Chairperson
2.	Prof. Kalaiselvi, MD Vice-Principal, MMC, Ch-3	-- Member Secretary
3.	Prof. Nandhini, M.D. Inst. of Pharmacology, MMC, Ch-3.	-- Member
4.	Prof. Bhavani Shankar, M.S. Prof & HOD of General Surgery, MMC, Ch-3.	-- Member
5.	Prof. V. Padmavathi, M.D. I/c Directory of Pathology, MMC, Ch-3.	-- Member
6.	Thiru. S. Govindasamy, BABL	-- Lawyer
7.	Tmt. Arnold Saulina, MA MSW	-- Social Scientist

We approve the proposal to be conducted in its presented form.

Sd/Chairman & Other Members

The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information / informed consent and asks to be provided a copy of the final report.

26/3/14

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE
CHENNAI-600 003

Member Secretary, Ethics Committee

26/3/14

MASTER CHART

wS.NO	NAME	AGE	SEX	I.P.NO	MODE OF INJURY	NAILING/ PLATING	WEIGHT BEARING	union	ROM ANKLE	ANKLE SCORE	ROM KNEE	KNEE SCORE	COMPLICATION
1	RAJESHWARI	48	F	52704	RTA	NAILING	IMMEDIATE	5	FULL	90	FULL	76	
2	RAMALINGAM	55	M	60184	RTA	NAILING	IMMEDIATE	6	NEAR NORMAL	95	FULL	81	DELAYED UNION
3	RATHINAM	44	M	59757	RTA	NAILING	IMMEDIATE	4	FULL	90	FULL	65	
4	PONGODI	35	M	57177	RTA	NAILING	IMMEDIATE	4	FULL	85	FULL	66	
5	BANU	36	F	58134	RTA	NAILING	DELAYED	4	FULL	90	FULL	60	
6	MALLIGA	47	F	42774	RTA	NAILING	DELAYED	5	NEAR NORMAL	95	NEAR NORMAL	71	MALUNION
7	RAJALAKSHMI	33	F	14675	FALL FROM HEIGHT	NAILING	IMMEDIATE	4	FULL	90	FULL	79	
8	MARY	47	F	84254	RTA	NAILING	IMMEDIATE	5	FULL	85	FULL	71	SUPERFICIAL INFECTION
9	VARADHAN	44	M	59757	RTA	NAILING	IMMEDIATE	5	FULL	90	NEAR NORMAL	74	MALUNION
10	INDRA	40	F	17667	RTA	NAILING	IMMEDIATE	4	FULL	85	FULL	74	DELAYED UNION
11	SUNDARAM	55	M		RTA	NAILING	IMMEDIATE	5	NEAR NORMAL	85	NEAR NORMAL	76	MALUNION
12	MURUGESHWARI	60	F		FALL FROM HEIGHT	NAILING	DELAYED	4	NEAR NORMAL	90	NEAR NORMAL	76	
13	GUNASEKARAN	27	M	60134	RTA	PLATING	DELAYED	5	FULL	70	FULL	80	SUPERFICIAL INFECTION
14	SIVAGAMI	60	F	61382	TWISTING OF ANKLE	PLATING	DELAYED	4	NEAR NORMAL	85	FULL	78	
15	MALLIGA	48	F	77702	RTA	PLATING	DELAYED	8	FULL	65	FULL	77	WOUND DEHISCENCE
16	DECRUZ	50	M	81234	RTA	PLATING	DELAYED	10	MID RANGE	65	FULL	88	IMPLANT FAILURE AND NON UNION
17	BALACHANDHAR	39	M	85267	RTA	PLATING	DELAYED	10	MID RANGE	70	FULL	86	PLATE EXPOSED
18	RAGHU	41	M	91816	RTA	PLATING	DELAYED	4	FULL	75	FULL	89	WOUND DEHISCENCE
19	RAMESH	40	M	30131	RTA	PLATING	DELAYED	4	FULL	70	FULL	80	
20	DURAISAMY	52	M	59053	TWISTING OF ANKLE	PLATING	DELAYED	5	MID RANGE	75	FULL	88	TENDON EXPOSED
21	KANNAN	42	F	99145	FALL FROM HEIGHT	PLATING	DELAYED	5	NEAR NORMAL	75	FULL	78	WOUND DEHISCENCE
22	SUNDHAR	52	M	2986	RTA	PLATING	DELAYED	4	FULL	75	FULL	93	
23	MUTHAMMAL	50	F		RTA	PLATING	DELAYED	5	FULL	80	FULL	88	
24	LAKSHMI	46	F		RTA	PLATING	DELAYED	5	NEAR NORMAL	75	FULL	86	